Intra-household Resource Allocation and Inter-household Risk Sharing in China

by

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Declaration

This thesis contains my own work except where otherwise indicated.

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2003.8.

Acknowledgment

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It should be noted that Dr. Meng also has a current research paper on the health effect of the Great Chinese Famine in 1959-1961. There was close contact during the initial stage of Chapter 2, since then I have proceeded independently and the methodologies employed are different.

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Abstract

This thesis consists of eight chapters. It focuses on Chinese household behaviour with regard to return to health, resource allocation within the family and inter-household risk sharing. Chapter 1 is an introduction. Chapter 2 uses the famine as a natural experiment to estimate the return to attained height of individuals. In this study, we find that annual income increases by 2.5 percent if attained height is increased by 1 cm.

To further investigate the linkage between health status and labour market productivity, we examine the calorie intake elasticity with respect to individual health endowments for males and females (Chapter 3). We find that the health endowment affects the allocation of food among family members of the Chinese rural economy. This elasticity is greater for women than for men. Chapter 4 assesses the effect of the location of the husband's mother-in-law on the allocation of resources between husband and wife. We find that the relative share of the husband's nutrient intake, relative to his wife's intake, decreases when his mother-in-law lives in the same village or neighbourhood, but increases if his mother-in-law lives outside the county in which the husband's family is located. We reject the hypothesis that a multi-person household can be treated as single decision-maker and this chapter sheds light on the degree of intra-family discrimination against wives.

Chapter 5 moves to the problem of risk sharing between households. The full consumption insurance hypothesis is tested. The full consumption insurance hypothesis is rejected for rural areas, but not urban. Furthermore, full insurance cannot be rejected

within villages, but is completely rejected across villages. Our results suggest that to some extent the degree of insurance deteriorates with distance.

Chapter 6 examines the response of consumption to major illness shocks. The results suggest that households without medical insurance are able to insure their consumption against minor illness shocks but not major ones. Chapter 7 provides an explicit estimate of the parameters in the utility function that reflect the strength of the precautionary saving motive. Our results produced a significant relative prudent coefficient, which is about 4 (hence the risk aversion is about 3 for the Constant Relative Risk Aversion (CRRA) utility function) for village representative consumers based on the assumption of complete risk sharing within a village. Our findings suggest that the village unit approach "works" in estimation of precautionary saving model, and this approach may be a possible way to solve Dynan's puzzle.

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Chapter 1

Introduction

1.1 Questions and motivation

The last twenty years has seen remarkable changes in economic performance in China. China has been fairly successful in its transition from a planned economy to a market oriented economy: from an agricultural dominated society to a more modern industrialised society. It is very impressive that China enjoys a very high private savings rate, a high investment rate and high economic growth. During this period of economic reform, the living standard has increased dramatically. Many studies have been conducted which have tried to understand this success story, however, very few have used micro data to understand decision making at the household level on a variety of economic issues[1].

This thesis looks at three important research areas, the relationship between health and the labour market, the sharing of food within households and the extent of insurance

[1] Recently, the number of empirical studies based on micro data has been increased. Meng (1999) includes sound empirical research on various labour issues in China.

across households. It asks questions such as: " What is the economic return to health in the rural labour market? How does food allocation within the family take into consideration the links between health and labour market productivity? Does the informal insurance mechanism between households shield a household's consumption from income fluctuations? What are the policy implications of incomplete consumption insurance?"

If these questions can be answered empirically, the findings will have important policy implications and methodology issues will be raised which will require further analysis of the Chinese economy.

It is believed that the accumulation of human capital is associated with economic growth. Recently, a number of studies have indicated that better health is associated with better labour market outcomes (Strauss and Thomas 1998). Is this true in rural China? This is completely an empirical problem. Indeed, if health is rewarded in the labour market, we may need to take this factor into consideration when we evaluate the effects of government health expenditure. In recognition of this, the Chinese government is increasing health expenditure in order to improve people's health. For instance, an intense program has been launched to supply all rural residents with clean drinking water.

During this period of rapid economic growth, inequality has increased dramatically. To better understand the issue of inequality, it is necessary to examine inequality within the family. When the presence of a linkage between health and labour market productivity affects the distribution of household food, policy makers need to shape their welfare policy to better target the needs of vulnerable individuals such as unhealthy females and children. These are the individuals who are most likely to be discriminated against in respect to household food distribution.

Many studies (among others, World Bank 1997) suggest that the most challenging issue facing China today is the lack of a sound social security system. China is making efforts to establish medical insurance, unemployment insurance and pension systems. However, these newly established systems only cover urban residents. This is because (1) the government lack resources to establish systems that will cover the entire population; (2) policy makers assume (presumably) that informal insurance mechanisms in rural areas may already work well enough to shield the consumption of households from various shocks. Therefore, we need to test how, and to what extent, households can smooth their consumption against various income shocks, is the key to making decisions concerning the establishment of social security systems in rural areas. For instance, if it can be determined that households in China are capable of smoothing their consumption against small shocks, but fail in smoothing consumption against greater shocks (such as major illness), it would be better for policy makers to use their limited resources to insure catastrophic events for both rural and urban residents.

The event of catastrophic illness is believed to be the major reason for the emergence of a new segment of the rural population living in acute poverty, since the 1980s. This may be due primarily to the fact that the cooperative medical insurance system, established under the planned economy, was completely destroyed in the 1980s, after the introduction of the family based agriculture system. We test whether households are now able to insure their consumption against illness. Our findings suggest that households cannot insure themselves against major illness and there would be substantial benefits from the introduction of a medical insurance scheme, for rural residents, that would cover major illness.

Savings issues in China have been discussed substantially, however, the purpose of family savings is far from being fully understood. Obviously, Chinese households face substantial risks and uncertainty during the transition period. But how strong is the precautionary saving motivation amongst consumers? If policy makers are able to directly estimate the prudence coefficient of consumers, they can design their policies to be more effective. For example, how much would the incentive to save be reduced if policies that reduced the risk and uncertainty facing consumers were introduced? By how much would the welfare of individuals be improved? To answer these questions require knowledge of structural parameters such as the prudence coefficient.

1.2 Outline of the thesis

This thesis consists of eight chapters. Chapter 2 examines the return to health in rural areas in China. We proxy health by individual height. A basic concern for the development economist is whether an increase in investment in health results in an increase in income. Estimating the return to health is the first step in understanding the complex interrelationship between health and economic development. Height reflects investment in human capital made on the individual during childhood. It might be thought of as a predetermined variable in a regression of an earning equation. We argue that many factors such as family background characteristics and liquidity constraints are likely to influence both height and earnings, so the Ordinary Least Squared estimation of the return to health may be biased.

We estimate the returns to height by using, as a natural experiment, the great Chinese famine of 1959-1961. The great famine created exogenous variations in nutrition investment on height across regions and cohorts. These exogenous variations can be used to identify the changes of height that were caused by the famine. This exogenous change of height is then used in the earning equation to identify the return to height in rural areas. This identification strategy overcomes the omitted variable bias problem and a consistent estimate of return to height can be achieved. In addition, our strategy also allows us to establish a causal relationship between health and labour market outcomes.

Chapter 3 investigates how resources are allocated within the family, taking into consideration the links between health and productivity in the labour market. Chapter 2 offers us some evidence that health (strength) is indeed rewarded in the rural labour market. The links between health and productivity may have a substantial effect on food allocation within poor families.

The idea of food allocation within the family, taking into account links between productivity and health, is quite simple. Given a limited quantity of food, the family planner may allocate more food to the individual with higher health status because that individual can earn more if they are involved in an activity where good health strongly augments productivity, and where effort depletes health status. In this case, increased food consumption both compensates for, and enhances, the return from increased effort.

To examine the relationship between household distribution of food and activities, we first estimate a health production function where nutrition intake and labour market activity variables have been instrumented. Secondly, we calculate the health endowment of the individual from the health production function. Finally, the effects of health endowment on calorie consumption, income and activity choice are examined.

Chapter 4 moves to gender bias issues within the family. In Chapter 3, we found that food distribution within the family is associated with activity distribution within a common preference model. In the common preference model, a family is treated as a homogenous entity. The other leading model (the bargaining model) regards the household as a group of individuals who bargain with each other over available resources. Chapter 4 tries to test which model most correctly describes the household decision making process i.e. common preference model or bargaining model.

Our concept is simple. For the common preference model, income is assumed to be pooled within the family. Individual consumption is determined by the total pool of family resources and the price of commodities, and will not respond to individual social economic characteristics that do not shift with taste. In contrast, the bargaining model assumes that the social-economic characteristics associated with bargaining power will alter the patterns of household consumption distribution. We examine if relative consumption between husband and wife depends on the location of the mother-in-law. We argue that the wife's bargaining power might be enhanced when her natal family lives near her married home and that she may receive relatively more consumption compared to her husband when this is the case. This test suggests that the common preference model might be more realistic in describing resource allocation within the family. The policy implications of this study are really interesting and important. If the target of family income support programs were to be changed, from the husband of the household to the wife, this may increase the wife's bargaining power and significantly reduce gender bias within the family.

Chapter 2, 3 and 4 focus on household decisions concerning resource allocation within the family. Chapter 5 onwards considers risk sharing behaviour among households.

In Chapter 5, we conduct a full consumption insurance test in the context of the Chinese economy. Hall's paper (1978) derives an implication of consumption smoothing over time, called the Martingale hypothesis. Many studies have been done to test the Martingale hypothesis. However, this landscape was altered by Cochrane (1991), Mace (1991) and Townsend (1994), who derived an implication of consumption smoothing across different states of nature. Hall's model is really a model of self-insurance. The representative agent in Hall's model can only shield consumption from income fluctuation through savings and investment in safe assets. The agent is cut off from all the other forms of insurance mechanisms. The full consumption insurance hypothesis suggests that individual consumption will co-move with aggregate consumption, and will not respond to idiosyncratic shocks.

We test the extent of full consumption insurance in the context of China, where the degree of consumption insurance has important policy implications due to the fact that China is beginning to establish a new social security system that will include medical and unemployment insurance and a pension system. We also compare the degree of consumption smoothing, against income shocks, for residents living in rural areas and urban areas. This test allows us to understand the effectiveness of existing formal and informal insurance mechanisms that help households protect consumption from income shocks.

Chapter 6 continues to test the full consumption insurance model. The weakness of studies of full consumption insurance, using income shocks, is that: (1) income shocks may be measured with serious errors and we may overstate the degree of insurance; (2) households may insure themselves from risks by choosing safe but low productive production methods before income is realised and we may overstate the efficacy of existing insurance mechanisms. In this chapter, the full consumption insurance hypothesis is tested using illness shocks. The rich data that is available on symptoms and their effects on individual work performance and daily activities allows us to better estimate the degree of consumption insurance. In addition, since only urban residents are able to access formal medical insurance, we can also compare the effectiveness of formal and informal medical insurance systems on consumption insurance, against illness risks.

As argued above, contrary to Hall's formulation of the Life Cycle-Permanent Income hypothesis, the empirical evidence suggests that households do combine self-insurance with inter-household transfers to protect consumption from income shocks. This fact is extremely important in the analysis of consumption decisions and has significant policy implications for governments.

Chapter 7 estimates the prudence coefficient which measures how prudent consumers are, by following Dynan's (1993) methodology. Our focus is to incorporate risk sharing considerations into the specification. We argue that the prudence coefficient in Dynan's specification will not be identified when the agents, in the economy, share risk completely. We assume the existence of full consumption insurance within the village or neighbourhood, then estimate the village representative consumer's prudence coefficient at the level of villages. The measurement error of consumption has been reduced dramatically through averaging over all individuals within the village. However, the variation of consumption growth across villages still allows us to estimate the prudence coefficient. Our estimated prudence coefficient is consistent with that widely accepted by economists. Our methodology suggests a possible way of solving Dynan's puzzle.

Chapter 8 presents a short conclusion. The main results of the thesis have been summarised. The potential weakness of this thesis and possible further research are discussed.

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Chapter 2

Health Consequences of the 1959-1961 Famine in China and an Estimate of the Return to Health

2.1 Introduction

The question of whether an increased investment in health causes an increase in income is a basic concern for development economics. Over the past 20 years, investment in human resources has taken centre stage in the study of developing economies. Numerous sets of wage equation estimates provide the basis for calculating market returns to education for almost every economy in the world. However, the link between health and labour market outcomes has received far less attention in the empirical literature. Recently, however, considerable attention has been directed toward understanding the complex interrelationships that exist between health and economic development (see the interesting survey by Strauss and Thomas 1998).

This chapter attempts to estimate the return to height, which reflects the accumulation of human capital early in life, by using as a natural experiment the Chinese famine of 1959-1961. The great famine in China between 1959-1961 resulted in an exogenous source of variation in nutrition investment, which impacted significantly on the height of individuals. This fact allows us to estimate the impact of nutrition as an investment on height.

The height of a person embodies substantial information about their health. It has been widely used as an indicator of wellbeing in both economic theory and in the development literature. Robert Fogel (1992,1994) linked aggregate movements in adult height to long run changes in standards of living by drawing on historical series on the stature of adults in the US and Europe. Strauss and Thomas (1998) documented the link between attained height at maturity and economic development in the last century in the US, Brazil, Cote Divoire and Vietnam. Strauss established links between a substantial increase in attained height at maturity and increases in living standards. In household data, there is a good deal of direct evidence indicating that income and health are correlated. For example, the height of children tends to increase with income in many low-income level countries.

Above all, although height is influenced by the genes inherited from parents, it also reflects investments made in the individual during childhood. We might interpret height as an indicator of human capital much along the lines of education. Height affects labour outcomes because it reflects a return to investment in human capital made during early childhood. Research has found that taller men earn higher wages (Haddad and Bouis 1991; Foster and Rosenzweig 1993; Thomas and Strauss 1997). The link between height and wages has also been noted in some historic literature.

One weakness of previous literature attempting to establish a link between height and income, was that height was treated as exogenous. Actually, Financial liquidity constraints, parent income and family background are likely to influence both height and earnings. In the literature that has estimated the return from years of schooling, economists have long realised that treating an endogenous factor as exogenous is a source of bias[2]. In developing economies this bias could be more important due to the fact that liquidity constraints are more serious than in developed economies because of the total absence of a credit market (or the existence of a poor one) and the very low level of income. However, it is difficult to find an exogenous variation in either education or height. Most factors that affect education (height) are also likely to affect income. For instance, the education of parents (height) and family assets, often used as instruments for education (height), are obviously correlated with earnings as well as being good predictors of education (height).

Angrist and Krueger (1991) proposed quarter of birth as an instrumental variable for education. Quarter of birth is arguably independent of unobserved factors such as ability or family background that affect income [3]. Other instrumental variables that have been introduced in literature include the Vietnam War lotteries (Angrist 1990) and the proximity of parents' residence to educational facilities (Card 1995). Duflo (2001) estimated the return to education using the variation in schooling generated by the school construction program in Indonesia.

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[2] Whether the returns to education in developing economies are over or under estimated is inconclusive and deserves further study Strauss, J. and D. Thomas (1995).

[3] There is some disagreement on the independence of quarter of birth from unobserved factors, see Bound, J., D.A. Jaeger and Baker. (1995).

This chapter exploits the exogenous variation in height created by the great famine of China in 1959-1961 to construct instrumental variable estimates of the effect of height on income. During 1959-1961, there was a large-scale famine in China resulting from the drop in food availability and different arrangements regulating rights to food (Lin and Yang 2000). Grain output dropped by 15% in 1959 and, in 1960 and 1961, output only reached about 70 percent of the 1958 level. Studies indicate that this crisis resulted in widespread famine and caused between 23-30 million excess deaths. Surprisingly, although there has been a great deal of research on the causes of the famine and the extent of excess deaths caused by this catastrophe, very little research has been done to evaluate health consequences for survivors of the great famine. It is obvious that the famine injured the health of the surviving population due to the lack of adequate nutrition. This had particular consequences for children who survived the famine because the famine directly affected children's height attainment. This health consequence affected their whole life if it can be determined that health and strength are rewarded in the labour market.

The identification strategy we have used to evaluate the effect of famine on height is that exposure to the famine varied between regions of birth and dates of birth. Since the causes of the1959-1961 famine i.e. bad weather, bad policies and bad management in the communes, incentive problems due to the large size of the commune and arrangements regulating rights to access food, are quite different from region to region. Substantial variations existed in the degree of famine across regions. This variation in the degree of famine can be measured by comparing regional excess death rates. This study proposes that the height of individuals, who were very young or reached puberty during the famine, should be less than that of other cohorts in regions that were not affected so severely by the famine. The difference-in-difference estimator is used to control for systematic variations of height both across regions and across cohorts. The combination of the two sources of variation of height is treated as exogenous. Similar strategies are often used in the evaluation of the effects of social programs. Duflo (2001) used a similar strategy to evaluate the effect of the school construction program on education.

In this chapter, the effects of the 1959-1961 famine on height, has been estimated using a large cross section of rural people born between 1945 and 1970 from the 1991 China Health and Nutrition Survey (CHNS). The exogenous variables are the interactions between dummy variables indicating the age of the individual in 1961 and the excess death rate in his/her region in 1960. The exogenous variation of height resulting from the famine is used as the first stage result in estimating returns to height.

We summarise the motivations underlying this research as follows:

Firstly, famine dramatically affects the health of people who survive it. Some effects last the whole of life. Life cycle health consequences have been ignored by previous research on the 1959-1961 famine in China.

Secondly, using variations in height created by the famine allows us to estimate returns to height more precisely. The findings of a causal link between income and height, which reflects the human capital accumulated during childhood, would provide evidence for models of a nutrition-based efficiency wage in the development literature (Stiglitz 1976, Dasgupta and Ray 1986).

Thirdly, knowledge of the nature and extent of the link between health and labour market outcomes is important for developmental policy. For example, agricultural development may be deemed more important if the development of human capital is directly linked to the potential for economic growth.

The remainder of this chapter is organised as follows. In section 2.2 we describe the 1959-1961 famine in China and the data. Section 2.3 discusses the identification strategy used to evaluate the effect of the famine on height. Section 2.4 estimates the effect of the famine on height. Section 2.5 estimates the returns to height. The final section briefly discusses the conclusions of this research.

2.2 Background and Data

Famine and food shortages have received substantial attention from economists. However comparatively few studies have examined the long-term health consequences for the survivors of famine. Poor nutrition during periods of famine causes a large number of individuals to die, however, at the same time, it also dramatically damages the health of the survivors. Some of this damage is likely to be permanent. To better understand the costs of famine, we need to estimate its health consequences.

Economists have realised that there are links between health and productivity, an example of this is the nutrition based efficiency wage model (Stiglitz 1976, Dasgupta and Ray 1986). However, questions such as: "Is human capital, measured as multi-dimensional health indicators such as height, weight and calorie intake, rewarded in the labour market?" and "What are the returns to these health investments?" have not been answered. These questions are of interest not only for the theorist but also for policy makers. However, until very recently, development economists have typically concluded that there is little reliable empirical evidence indicating that health has an impact on labour productivity.

In this chapter, we are interested in estimating the impact on attained height of the 1959-1960 famine in China and the returns to height in Chinese rural areas

Height reflects the human investment made in individuals during childhood by their parents. Human capital accumulation, such as height in early life, has a permanent physical effect. Therefore, the famine may have created a life-long cost since it may have dramatically reduced the accumulation of health capital for those who were in their childhood when the famine occurred.

2.2.1 The 1959-1961 Famine

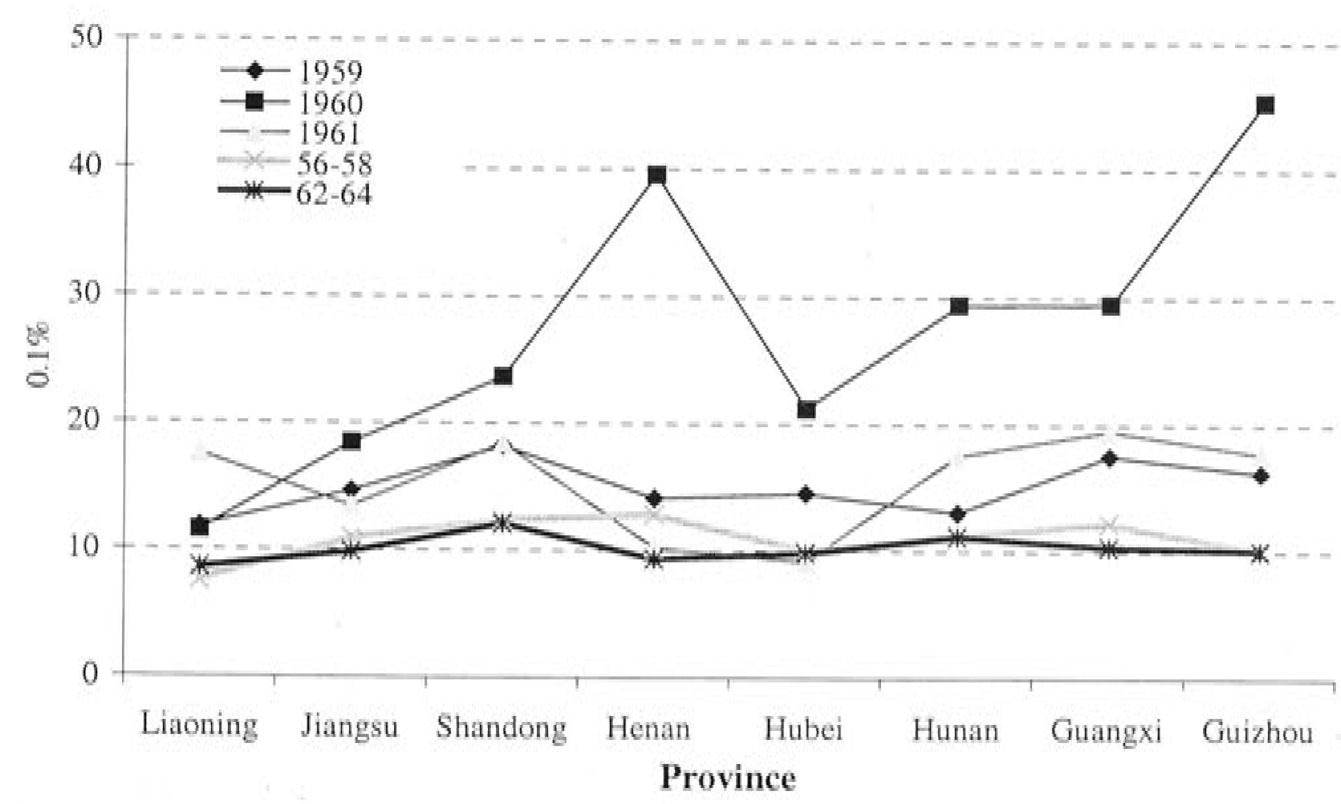
China initiated an agricultural collectivisation program in 1952. In 1958, as a consequence of collectivisation, large-scale communes were formed as part of a nation-wide "Great Leap Forward" movement. During the following three years, agricultural production dropped considerably and the great famine ensued.

During the period 1959-1961, the death rate (per thousand people) increased dramatically. The national death rates were 14, 25 and 14 per thousand for the years 1959, 1960, and

1961 respectively. The average death rate for 1956-1958 was about 11 per thousand and it is estimated that the famine caused about 23-30 million excess deaths (Ashton, Hill, Piazza and Zeitz 1984, Xizhe 1987).

The famine also created a large undernourished population during the three-year period. Malnutrition, resulting from the famine, severely affected the health of children. It caused muscle wastage and retarded growth (thus future capability). There is also evidence that malnutrition can affect brain growth and development (Dasgupta and Ray 1986). In addition, psychological changes, manifested by mental apathy, depression and lower intellectual capacity are associated with malnutrition. In this chapter, we are interested in the total effect of famine on children's development. We try to estimate precisely to what extent the attained height of Chinese rural people was reduced by the famine.

Figure 2.1: Death Rates in the Chinese Provinces



Firstly we notice that the famine was distributed unevenly across regions. Figure 2.1 shows the death rate in eight Chinese provinces for different years. During the period of the famine (1959-61), the death rate varied across regions, particularly in 1960. The death rate ranged from 11 per thousand in Liaoning to 45 per thousand in Guizhou. In the periods 1956-1958 and 1962-1964, the death rate lay on the normal level, and variations across regions were very small. Table 2.1 presents the death rate data for eight provinces between 1956 to 1964.

Table 2.1: Death Rates in the Chinese Provinces (per 1000)

	1956	1957	1958	1959	1960	1961	1962	1963	1964
Liaoning	6.6	9.4	6.6	11.8	11.5	17.5	8.5	7.9	9.3
Jiangsu	13	10.3	9.4	14.6	18.4	13.4	10.4	9	10.1
Shandong	12.1	12.1	12.8	18.2	23.6	18.4	12.4	11.8	12
Henan	14	11.8	12.7	14.1	39.6	10.2	8	9.4	10.6
Hubei	10.8	9.6	9.6	14.5	21.2	9.1	8.8	9.8	10.9
Hunan	11.5	10.4	11.7	13	29.4	17.5	10.2	10.3	12.9
Guangxi	12.5	12.4	11.7	17.5	29.5	19.5	10.3	10.1	10.6
Guizhou	7.5	8.8	13.7	16.2	45.4	17.7	10.4	9.4	10.5

Source: State Statistical Bureau (adapted from Lin and Yang (2000) pp147)

The fact that exposure to famine (resulting in starvation) varied by region is a key component used to identify the effects of the famine on the health of individuals. The other fact exploited is that because different cohorts were affected differently by the famine, we can then follow through the proposition that the height of individuals who were babies or reached puberty during this period would be more seriously affected by the famine. Combining these variations across regions and cohorts, we can use the difference-in-differences estimator to identify the effect of famine on height.

The variation in attained height created by the famine can then be used to estimate the return to height in an earning equation. This natural experiment method is used as a control for any omitted variable bias in the earning equation.

2.2.2 Data[4]

The data used in this study is drawn from panel data of the China Health and Nutrition Surveys (CHNS) of 1989, 1991 and 1993. These surveys were conducted by the Carolina Population Center at the University of North Carolina, Chapel Hill, The Institute of Nutrition and Food Hygiene, and the Chinese Academy of Preventive Medicine. The data information can be found on the web site: www.cpc.unc.edu/projects/china.

The CHNS was designed to examine the effects of health, nutrition, and family planning policies in China. The survey focuses on issues related to social economic change in China and the effect that these changes have on the health and nutritional status of its population. The survey collects detailed information about households and individual economic, demographic and social characteristics, community organisations, individual food consumption, nutrition intake and health status.

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[4] Most of the work in this thesis is based on the data set of the China Health and Nutrition Survey (CHNS). We give a detailed overview of this survey in this chapter. In the following chapters, details of the data set will be described, as necessary.

The 1989 survey included 3,795 households and, in 1991 and 1993, 3,616 and 3,441 households respectively, attended the survey. In 1989, health and nutritional data was collected only from preschoolers and adults aged 20-45. The 1989 survey covered 15,917 individuals. All individuals in each household were surveyed in 1991 and 1993 for all data.

A multistage, random cluster process was used to draw the sample survey in each of the provinces[5]. The 190 primary sampling units consisted of 32 urban neighbourhoods, 30 suburban neighbourhoods, 32 towns and 96 villages. In the context of China, suburban is usually still thought of as rural areas in terms of administration. A town is an urban area.

The data consists of surveys of households, health and nutrition, community, food markets and health and family planning facilities. The household surveys contain detailed information about individual and household characteristics, time allocation at home and economic activities and income from various sources.

Individual dietary intake for three consecutive days was recorded for every family member. Health status measurements such as height, weight, arm and head circumference and mid-arm skin fold measurements were collected for all individuals.

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[5] The data released does not include weight for each observation. In most of our studies, this might not be a serious problem because we won't try to derive the estimations for the whole population in most of our studies.

The information on community infrastructure and services has been collected from a knowledgeable respondent. Food market surveys cover information about prices for a representative basket of commodities from state and free market stores.

Figure 2.2: Map of Survey Regions

Note: The darker shaded regions in the map above are the provinces in which the survey was conducted.

The CHNS data used covers 8 provinces, namely: Guangxi, Guizhou, Henan, Hunan, Jiangsu, Liaoning and Shandong. This sample is diverse in many dimensions, for instance, social economic factors, health and demographic measures.

The locations of the eight provinces are shown in the Figure 2.2. Heilongjiang province was added after 1993.

In this chapter we focus on a sub-sample of adult rural residents born between 1943 and 1970. Figures 2.3-2.6 shows the kernel Nearest Neighbour (kNN) regression estimates for attained height in 1991, by regions and gender. kNN calculates non-parametric regression estimates by means of the k-Nearest Neighbour estimator. We have drawn a scatter plot of the original observations overlaid with the estimated conditional mean represented as a continuous line without any symbols.

Through careful observation of the figures, it can be seen that the mean height of the cohort born in 1959-1961 is slightly lower than that of the nearest cohorts. This offers us a rough picture of the effect of the famine on height attainment.

2.3 Econometric Issues and the Model

2.3.1 The Identification

Here, we attempt to estimate the effect of famine on height using a difference-in-difference method. This estimate is based on the fact that exposure to famine varied by regions of birth and date of birth. The combination of the effect of these two variations in height is treated as the effect of the famine.

Exposure to famine is different for cohorts. A person's height should not be affected by the famine if they were born after the famine period. Similarly, people who were over 18 years of age during the famine had already attained their adult height. At the same time, for the cohort that was 0 to 18 years old in 1961, there is a high probability that their height attainment could have been affected by the famine. Furthermore, the height attainment of two particular age groups is generally believed to have been affected to a greater extent than others. These groups are (a) children who were under 3 years old in 1961 and (b) those who were 12 to 14 (i.e. those adolescents reaching puberty in 1961). The height attainment of individuals in these two vulnerable groups might be affected to a greater extent than other age groups exposed to famine. Within the first group, the effect of the famine on height attainment is also different across the 1-3 age cohorts. For instance, a child born in 1959, the start of the famine, may have suffered much more than a child born in 1961, the year the famine ended.

Another key component for our estimate is the variation across regions. As documented in section 2.2, the severity of the 1959-1961 famine varied across regions. The excess death rate in Henan in 1960 was 37 per thousand, but almost zero in Liaoning province. Figure 2.1 compares death rates in eight Chinese provinces during the period of the great famine. This figure shows an obvious variation in death rate across regions in China. The variation of the seriousness of the famine would have created different effects on the height attainment of treated individuals.

It is worth noting that our estimate of the effect of famine on height attainment requires that the region of birth is highly correlated with the region of growing up. This correlation is very strong for rural people in China. Many researches have documented the fact that there was very little rural migration across provinces before the 1990s (Meng 1999). For reasons of political and economic development strategy, the Chinese government severely restricted migration between regions through a resident registration policy, called the "Hukou" system. Migration under the planned economy needed to be approved by authorities on a case by case basis. In this chapter, we only use rural residents because it is more likely that the region of birth would be the same as the region of growing up for the majority of rural people during the period covered by the study.

The 1959-1961 famine went unnoticed outside of China until the release of important demographic data by the Chinese government in the early 1980s. The 1959-1961 famine did not result in a flood of migration, the usual indicator of famine observed during famine in other countries. This is because all rural residents were organised into hundreds of thousands of Communes that were managed in a quasi-military fashion and free migration was completely prohibited. As a result, the region of birth is highly correlated with the region of growing up. Furthermore, the region of birth is not endogenous in respect to the famine.

Our identification strategies for the effect of the famine on height attainment are illustrated in Table 2.1. This illustration does not precisely estimate the effect of the famine on height as only a small part of the available information is used. However, it is through this simple example that we wish to demonstrate the idea of difference-in-difference estimation.

In this example, we categorise provinces into two groups according to the severity of the famine. High excess death rate regions include the provinces of Henan and Guizhou. In

1960, the excess death rates in Henan and Guizhou were 29 per thousand and 35 per thousand, respectively. The other six provinces can be considered regions of low excess death rate because, in 1960, their excess death rates each averaged approximately 13 per thousand.

This study uses two cohorts of people for comparison. The *treated* group is comprised of those individuals, who were born between 1959 and 1961, because the attained height of these individuals is likely to be affected by the famine. The *control* group is made up of those individuals who were born just after the famine (i.e. from 1964 to 1970), because the control group was not directly affected by the famine[6].

We compare the mean of attained height, by maturity (measured in 1991), of the treated group and the control group in both types of regions. The experimental results are presented in Table 2.2.1. The difference of height between low and high excess death rate regions for the treated group is –4.99 cm. This is much greater than the difference between the two regions for the control group (i.e. –1.85 cm). The difference in these differences is –3.14 cm, which can be interpreted as the causal effect of the famine on attained height. The underlying assumption is that the increase in attained height would not have resulted in systematic differences between the two region types.

[6] There is still some indirect effect of the famine on height attainment for individuals in the control group due to the fact that the mothers of individuals in the control group suffered from the famine. The poor health status of these mothers would also affect their children's height.

Table 2.2.1: Means of Height by Cohort and Degree of the Famine

	Excess death rate		
	Low regions	High regions	Difference
Born during 1959 to 1961	160.84	155.85	-4.99
	(8.20)	(6.12)	
Born during 1964 to 1970	160.70	158.85	-1.85
	(7.84)	(7.64)	
Difference	-0.13	3.0	-3.14
			(1.21)

Note: Standard errors are in parentheses

In this simple illustrative example, the estimate of the effect of famine is –3.14 cm (the standard error is 1.21 cm). This suggests that the famine in Henan and Guizhou province dramatically damaged the health of individuals, hence reducing their attained height by maturity. The validity of this difference-in-difference estimate depends on the assumption that changes in attained height by maturity do not vary systematically across regions. In other words, if the change in attained height was negatively correlated with initial levels, the difference-in-difference estimate will be significant even if famine does not affect an individual's height (Meyer 1995).

Therefore, we need to test this identification assumption. In order to do this, we consider two groups of people, both of whom were not exposed to the famine. Groups chosen for the controls are those individuals born between 1964 and 1967, and those born between 1968 and 1970. Similarly, we compare the mean of height for these groups in both types of regions. By doing this, we wish to demonstrate that the changes in height attainment between these two cohorts do not differ systematically across regions.

Table 2.2.2 presents the result of this experiment. The estimated difference-in-differences is 0.97 cm. This is not a significant variation from zero (the standard error is 1.1 cm). These experiments suggest that difference-in-difference is an appropriate approach by which to estimate the effect of the famine on height attainment. In this chapter, we will elaborate on this strategy to produce a more precise result.

Table 2.2.2: (Experiment) Means of Height by Cohort and Degree of the Famine

	Excess death rate		
	Low	High	Difference
Born during 1964 to 1967	160.84 (7.69)	158.54 (8.02)	-1.3
Born during 1968 to 1970	160.51 (8.05)	159.18 (7.24)	-0.33
Difference	-0.33	0.64	-0.97 (1.10)

Note: Standard errors are in the parentheses

2.3.2 The Model

Attained height reflects human investment during childhood. To discuss this concept, it is useful to begin with a simple household production-function model. For convenience, assume a single person household that maximises utility over two periods. Period zero is childhood, from age 0 to about age 20. Period one is the rest of life. Since our focus is on the estimate of the return to height and the cost to health of the famine, we assume that there exists a generic health production function for an individual:

$$H = H(N_0, B, \mu, O_0) \tag{2-1}$$

where H represents height, it depends on a vector of health input N_0 in period zero. The technology underlying the height production is also affected by the individual's family background B, such as parental health, education, liquidity constraints and environmental factors. μ refers to the measurement errors or other unobserved factors. O_0 in the health production function refers to other related variables.

When a child arrives in period one of the life cycle, he/she enters the labour market. The real wage received is assumed to equal the worker's marginal product. His/her wage varies with health outputs, such as H. Wages also depend on other traits such as education (S), family background (B), ability (α) and many other variables (O_1). Wage function in period one may be written as:

$$W = W(H, S, B, \alpha, O_1) \tag{2-2}$$

This function is a standard earnings equation that is widely used in labour economics. We use this equation to estimate the return to height, an indicator of health output in the early stage of life. Labour economists have recognised for a long time that estimated returns to education are biased because of omitted variables such as unobservable individual ability and some family background factors that can affect both education and wages (Griliches 1977). The same problem arises when we try to estimate the return to height. Some omitted unobservable variables such as liquidity constraints and inherent health factors may be correlated with both wages and height. For example, a person from a rich family is not only likely to earn more money because of his/her background and the business experience of the family, but also to be taller since he/she has been be well nourished during childhood.

To close the model, assuming that people's welfare depends on current consumption (C), health output (H), family background factors (B) and tastes (ξ), we may write the utility maximization problem as follows:

$$MaxU = U(C_0, H, B, \xi) + U(C_1, H, B, \xi), \tag{2-3}$$

subject to the above health production function, earning equation and budget constraints:

$$C_0 + P_0 N_0 + A = V_0 \tag{2-4}$$

$$C_1 + P_1 N_1 = A + WL,$$

where C is non-nutrition consumption, its price is normalised as one, P is price of nutrition input, A is savings. We assume labour supply (L) is given. To simplify the equation, we have assumed that there is no discount and no interest. Solving this equation, we can obtain the optimal consumption of N, which is a function of its price. By substituting the result into the health function, the height becomes a function of the price of health input and the other exogenous variables.

Optimal height is determined through equating the marginal benefit and marginal cost of height. To capture the effects of the famine, we can write the marginal cost of height as a function of the excess death rate and other regional characteristics. In fact, the price of health input increased dramatically during the famine period. Therefore we may write our statistical equation as follow:

$$H_{ijk} = con + \alpha_j + \beta_k + \gamma(edr_j * T_i) + C\delta + \xi_{ijk} \tag{2-5}$$

where H_{ijk} is attained height by maturity in 1991 for individual i, born in region j, in cohort k. α_j is the region fixed effect, β_k is the cohort fixed effect, edr_j is the excess death rate of region j in 1961, T_i is a treatment dummy indicating whether the individual was exposed to the famine in the sample, C represents the other control variables, ξ_{ijk} is the error item.

Equation (2-5) is our basic estimated equation. The coefficient of the interaction between the excess death rate and the treatment dummy shows the causal effect of the famine on height attainment.

The predicted value of height from the estimated equation (2-5) can act as the first stage in estimating the earning equation (2-2) by using the Two Stage Least Squares (2SLS) method. In this case, as Imbens and Angrist (1994) argue, the instrumental method allows us to interpret a causal link between height and income.

2.4 The Health Consequences of the Famine

To estimate the health consequences of the famine, we estimate (2-5). The dummy for treatment in (2-5) can be replaced with T_{il}, which is a dummy indicating whether individual i was of age l in 1961. This year of birth dummy may offer us more detailed information in the estimation than if the estimation was made using only a simple dummy for the whole treatment cohort.

$$H_{ijk} = con + \alpha_j + \beta_k + \sum_{l=0}^{18} \gamma_l (edr_j * T_{il}) + C\delta + \xi_{ijk} \ . \qquad (2\text{-}6)$$

We expect that the effect of the famine on a baby should be greater than on any other age cohort. Knowledge of physiology tells us that lack of nutrition for an individual in babyhood may result in serious permanent damage to his/her health. Some of this damage affects his/her attained height. In addition, the length of exposure to the famine was different for the cohort born between 1959 and 1961. A baby born in 1959 may have suffered more than the baby born in 1961 since the famine lasted about three years.

Moreover, we expect to observe that the effect of the famine on height should also be greater for the cohort aged 13 to 14 in comparison to other treatment cohorts. An individual of 13 to 14 years old is in puberty. This is an important period in the human lifecycle, particularly in aspects of physical development and growth.

Table 2.3 presents the estimated results for equation (2-6). Our sample includes 3,435 observations from rural areas in China. People born before 1943 or after 1970 are excluded. The reason for dropping observations relating to people born after 1970 is that they were less than 20 years old when the data was collected and some may argue they were still growing in 1991. Individuals born before 1943 may have shrunk as a result of ageing. Individuals born in 1962-1964, are also excluded as this was a transition period following the famine. In summation, our sample includes those individuals born between 1943 and 1961, and individuals born between 1965 and 1970.

The excess death rate data for the eight provinces used in the estimation come from Table 2.1. The excess death rate in 1960 is calculated as the gap between the death rate in

1960 and the three years average death rate before 1959. We use excess death rate to proxy the severity of the famine. The seriousness of the famine was closely correlated with food prices and other costs of health input.

The complete results can be found in Table A2.1 of the Appendix. Table 2.3 only presents the coefficient of interactions of individual ages in 1961 and excess death rates. As discussed in section 2.3, these coefficients are the estimated effects of the famine on height attainment. From the results, the cohorts of children aged 1, 2, 4 and the cohort of adolescents aged 13-14 were significantly affected by the famine. These results are as expected[7]. The fact that the attained height of children who reached puberty during the famine was affected much more than younger cohorts, with the exception of cohorts of age 1 to 4, is consistent with physiological theory. This suggests that our estimates are fairly accurate.

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[7] We do not have satisfying explanations for why the coefficient is not significant for the cohort aged 3 in 1961.

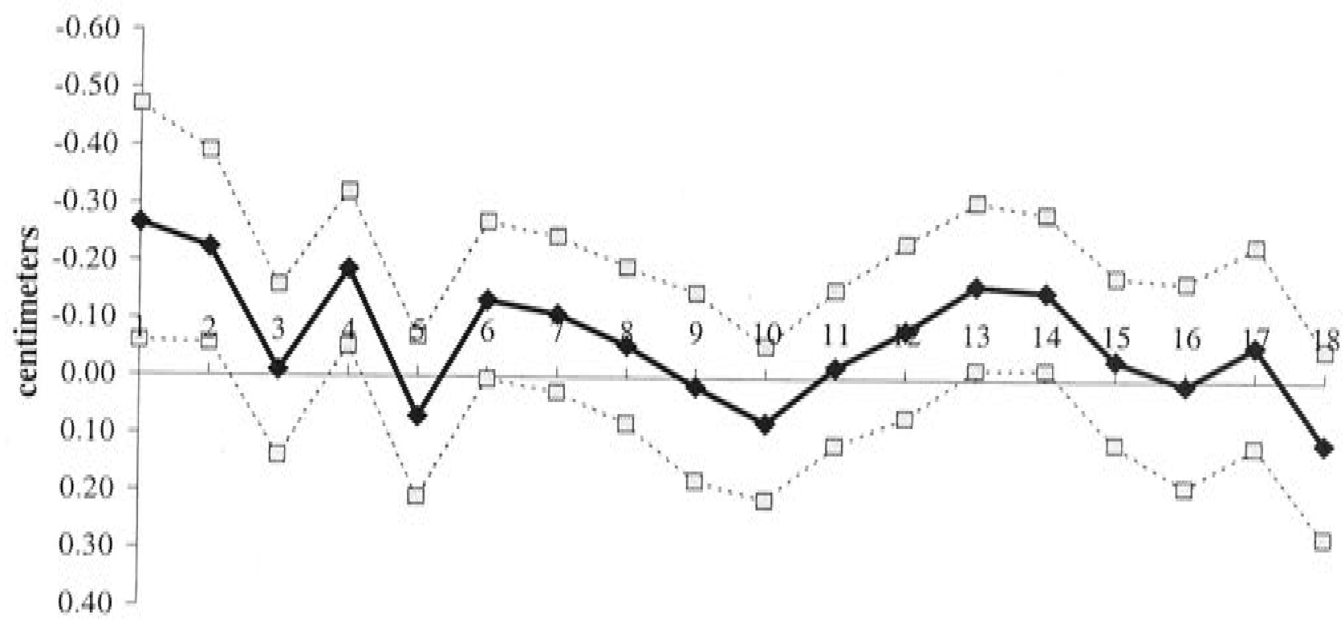
Table 2.3: Estimated Coefficients of Interaction of Age in 1961 and Excess Death Rate during the Famine

	Coef.	t
edr*age18	0.108	1.30
edr*age17	-0.061	-0.68
edr*age16	0.008	0.09
edr*age15	-0.034	-0.47
edr*age14	**-0.153**	-2.21
edr*age13	**-0.163**	-2.19
edr*age12	-0.084	-1.08
edr*age11	-0.019	-0.28
edr*age10	0.078	1.14
edr*age9	0.016	0.19
edr*age8	-0.056	-0.80
edr*age7	-0.109	-1.58
edr*age6	-0.133	-1.90
edr*age5	0.070	0.99
edr*age4	**-0.186**	-2.71
edr*age3	-0.010	-0.13
edr*age2	**-0.223**	-2.62
edr*age1	**-0.265**	-2.53
edr*age0	-0.004	-0.04
_cons	162.538	325.2
N	3435	
R sq	0.0682	

Note: the dependent is attained height (cm).

We have drawn the results from Table 2.3 in Figure 2.7. Each dot on the solid line represents the coefficient of the interaction between age in 1961 and the excess death rate. A ninety-five percent confidence interval is plotted in dotted lines. For instance, an individual of age 1 in 1961 was 0.265 cm shorter if he/she was born in a region whose excess death rate increased by one per thousand. The national average excess rate was about 18 per thousand in 1960. Therefore, on average, individuals of age 1 in 1961 would otherwise have grown 4.77 cm taller in the absence of the famine. Likewise, children reaching puberty during the famine period would otherwise have grown 2.8 cm taller if the famine had not occurred.

Figure 2.7: Coefficients of the Interactions of Age in 1961* Excess Death Rate in 1960



We also estimate a restricted version of equation (2-6), the results of which are presented in Table 2.4. In this instance, only the cohorts for ages 13-14 and 0-4, and their interaction with the excess death rate, are included in the estimation. The results are similar to that presented in Table 2.3.

Table 2.4: Restricted Estimate of Effect of Famine on Attained Height (cm)

	Coef.	t
age 14	2.161	1.59
age 13	2.063	1.45
age 4	2.004	1.63
age 3	0.186	0.15
age 2	2.736	2.02
age 1	3.743	2.48
age 0	-0.596	-0.34
ddeath60	-0.150	-9.62
edr*age 14	-0.137	-2.05
edr*age 13	-0.147	-2.04
edr*age4	-0.170	-2.57
edr*age3	0.006	0.09
edr*age2	-0.207	-2.49
edr*age1	-0.249	-2.41
edr*age 0	0.012	0.12
_cons	162.015	521.2
N	3435	
R sq	0.554	

In order for the difference-in-difference estimator to remain free from bias, changes in the excess death rate are not systematically related to other omitted factors that affect height. In Table 2.5, we show the results of the control experiment. Here, we compare the cohorts of individuals who were borne between 1965 and 1970. None of these cohorts were ever exposed to the famine. In this sample, the effects of the famine are very small and none of any statistical significance. This experiment suggests that the difference-in-difference estimator may work well in this case.

Table 2.5 Test of the Assumption of Difference-in-Difference Estimate of Effect of the Famine

h91	Coef.	t
b1965	0.421	0.25
b1966	-0.516	-0.31
b1967	2.357	1.23
b1968	-2.462	-1.38
b1969	0.065	0.04
b1970	1.001	0.58
ddeath60	-0.165	-2.80
edr*b1965	0.023	0.26
edr*b1966	0.065	0.75
edr*b1967	-0.092	-0.94
edr*b1968	0.148	1.67
edr*b1969	0.018	0.22
edr*b1970	0.020	0.24
_cons	162.481	145.82
N	986	
R sq	0.041	

In order to explore the gender related differences of the health consequences of the famine, we have also estimated equation (2-6) by gender. However, we did not find a significant gap between genders. This may come from the fact that it is the mother who takes care of the baby and in Chinese society mothers may not discriminate against their daughters.

2.5 Estimating the Returns to Height

We have estimated the impact on height of the famine in 1959-1961 in the above section. The reason for our concern about the health consequences of the famine is that we believe that health, as a dimension of human capital, will be rewarded in the labour market, particularly in developing countries. In this section we are concerned with the return to height. Attained height, which is a less subjective indicator of health status, may be directly related to productivity. Height reflects a previous investment in health that manifests itself as added strength and energy and can contribute to cognitive ability.[8]

The problem of estimating the return to height is similar to that arising from the estimation of return to education. OLS estimates suffer from the omitted variable bias problem, that is, height may be correlated with some omitted unobservable variables such as: liquidity constraint, genetic factors or other background factors. In the research on return to health, height is usually considered to be predetermined by the time an individual reaches adulthood (Thomas and Strauss 1997). The correlation between height and omitted unobservable variables, or measurement errors in height, result in a biased estimate of return to height. The direction of such bias is not always easy to identify.

We estimated the effect of the famine on height based on the assumption that the changes in height across cohorts would not have varied systematically between regions in the absence of the famine. The effect estimated from this method can be thought of as a causal effect of the famine. Furthermore, if we assume that the famine has no effect on earnings, other than through affecting people's accumulation of human capital, then we can estimate the return to height, using the famine to construct the instrumental variable.

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[8] Following the widely cited paper (Strauss and Thomas 1998), we estimate the return to height and interpret our results as a return to health status. There might be other reasons why labour market rewards are related to height. For instance, an individual may get higher payment because he/she is tall and looks charming. We can't distinguish these effects in this research.

Therefore, equation (2-6) can be used as the first stage estimate of a two stage least squared estimation of the impact of height on income.

Before presenting the results of our calculations, I will first describe the variables and the data used. The sample used in estimating return to height is the same as the one used in our previous estimation of the effect on height. Since we lack income information for some individuals, 3,312 observations from rural areas in China in 1991 are used. Since the majority of rural Chinese people are self-employed, wage data cannot be obtained. Also, since the beginning of 1980, China has conducted a system based on family responsibility in the agriculture sector. This system makes it is difficult to distinguish the contribution of individual members since family members work together on their allotted farms. In our estimation, we have used the per capita annual income of families as the dependent variable. The weakness of using annual income is that the income is the result of the combination of wages and work hours. Lack of control over labour supply will result in an inefficient estimate. We have assumed that work time (whether market or non-market) is the same for all farmers (there are few idle persons in low-income countries).

Based on these assumptions, we estimate the following equation:

$$\ln(income) = \alpha + \beta height + \gamma controls + \varepsilon \ , \qquad (2\text{-}7)$$

where the unit of height is measured in centimetres. *controls* is a vector of control variables, including years of schooling, age, age squared, a gender dummy, employment status, thirteen occupation dummy variables and five marriage status dummy variables.

The empirical results are presented in Table 2.6. Model 1 is an OLS estimation without height. The coefficient for education is 1.8% in Chinese rural areas. This means that the individual's annual per capita family income increases by 1.8 percent if years of schooling increase by one year. This estimate for education is possibly contaminated by the endogeneity problem. Model 2 includes height and the OLS was used again. The coefficient to education was reduce slightly from 1.8% to 1.7%, and the coefficient on height was very small, only 0.4% and not statistically significant.

In model 3, we have used the interaction between age in 1961 and the regional excess death rate to instrument the attained height measured in 1991. The height coefficient now is 3%, and the education coefficient is about 1.1%. Section 2.4 demonstrates that the famine, on average, reduced the attained height of an individual who was born in 1960 by 4.7 cm. As a consequence, his/her annual per capita family income decreased by 14% compared with what it otherwise would have been. For those who reached puberty during the famine, income is about 8% lower than it would be otherwise. This suggests that the famine had a huge impact on lifetime earnings through the damage to the health status of individuals. Meanwhile the coefficient of education fell from 1.7% to 1.1%. This change can be interpreted in terms of the effect of education on earnings operating through health. In rural China, agricultural mechanisation has not been realised and the majority of farm work still depends on a farmers' physical strength, energy and work endurance.

Table 2.6: Impacts of Height on log of Annual Per Capita Family Income

	Model 1: No height		Model 2: Include height (OLS)		Model 3: Include height (TSLS)	
linc	Coef.	t	Coef.	t	Coef.	t
height (cm)			0.004	1.62	0.030	3.35
edu	0.018	4.02	0.017	3.80	0.011	2.25
unemp	-0.14	-1.2	-0.139	-1.20	-0.137	-1.15
occup1	0.326	0.85	0.343	0.90	0.458	1.17
occup2	0.226	0.63	0.241	0.67	0.348	0.94
occup3	0.318	0.88	0.330	0.91	0.416	1.120
occup4	0.350	0.96	0.365	1.00	0.469	1.26
occup5	-0.46	-1.34	-0.442	-1.26	-0.260	-0.72
occup6	0.339	0.96	0.355	1.00	0.468	1.29
occup7	0.277	0.78	0.296	0.84	0.429	1.18
occup10	0.551	1.43	0.566	1.47	0.675	1.71
occup11	0.158	0.43	0.180	0.49	0.331	0.88
occup12	0.323	0.90	0.347	0.97	0.511	1.39
occup13	0.190	0.47	0.223	0.56	0.451	1.09
mary2	-0.92	-1.16	-0.915	-1.16	-0.910	-1.13
mary3	-0.99	-1.26	-0.999	-1.27	-1.026	-1.28
mary4	-0.96	-1.15	-0.956	-1.14	-0.906	-1.06
mary5	-1.18	-1.47	-1.170	-1.46	-1.132	-1.39
mary6	-0.79	-0.94	-0.803	-0.95	-0.851	-0.98
age91yrs	-0.05	-2.54	-0.045	-2.58	-0.050	-2.77
agesq	0.001	2.96	0.001	3.01	0.001	3.30
gender	0.158	5.48	0.196	5.26	0.463	4.84
_cons	8.312	9.19	7.634	7.66	2.902	1.56
N	3312		3312		3312	
R sq (%)	17.65		17.16		14.53	

Table 2.6 (continued): Impacts of Height on log Annual Per Capita Family Income

linc	Model 4: education is instrumented Coef.	t	Model 5: both height and education is instrumented Coef.	t
height (cm)			0.036	2.75
edu	0.073	2.54	-0.014	-0.32
unemp	-0.114	-0.95	-0.147	-1.21
occup1	0.091	0.22	0.581	1.29
occup2	0.068	0.18	0.436	1.08
occup3	0.252	0.68	0.461	1.20
occup4	0.254	0.67	0.531	1.35
occup5	-0.328	-0.90	-0.283	-0.77
occup6	0.350	0.97	0.486	1.32
occup7	0.346	0.95	0.426	1.16
occup10	0.607	1.54	0.673	1.69
occup11	0.153	0.41	0.364	0.95
occup12	0.370	1.01	0.524	1.40
occup13	0.249	0.61	0.472	1.12
mary1	0.713	0.82	0.897	1.02
mary2	-0.170	-0.51	-0.027	-0.08
mary3	-0.277	-0.84	-0.137	-0.41
mary4	-0.141	-0.32	-0.046	-0.10
mary5	-0.454	-1.27	-0.232	-0.63
age91yrs	-0.042	-2.30	-0.052	-2.80
agesq	0.001	3.10	0.001	3.23
gender	0.258	4.35	0.474	4.81
_cons	6.789	9.87	1.405	0.68
N	3312		3312	
R sq (%)	13.18		12.43	

Why are the instrumental estimated returns to height much higher than that from the OLS? The general belief, in the development literature, is that OLS estimates are likely to be biased upward due to omitted variables (Strauss and Thomas 1995). However, many researches in developed economies find that instrumental variable estimates are higher than OLS estimates (Card 1995,1999). There are several reasons for this. The first explanation is that the OLS estimates may be biased downward due to measurement error.

The attenuation effects of measurement error may dominate the upward omitted variable bias.

The second reason, according to Card (1995), is that the 2SLS estimate might not be estimating the average returns to height. People affected by the instruments might be people who have a higher marginal return to height. This implies that the return to height is a concave curve.

In Model 3, only height is treated as endogenous, but a similar argument applies to the variable for education. Accordingly, in model 5, we have treated both height and education as endogenous. The instrumental variables are still the interaction between age in 1961 and the excess death rate. In this calculation, the estimated effect of height on log income increased slightly, from 3% to 3.6%. However, the coefficient of education becomes statistically insignificant. This suggests three things. Firstly, height (hence strength and energy) is significantly rewarded in the labour market. Secondly, a substantial part of the effect of education on income operates through health. Thirdly, the natural experiment may not provide a good instrumental variable for education. If famine has a weak effect on years of schooling, this may lead to incorrect inferences (Bound, Jaeger and Baker 1995). The first stage result shows that the famine has a weak effect on years of schooling and the correlation between the famine and years of schooling is quite low[9]. According to Bound et. al. (1995), the 2SLS estimate of return to education will be biased. We guess that the famine may significantly affect the education quality rather

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[9] The results have not been reported here.

than years of schooling. So we need data for education quality to examine this issue in future.

In Model 4, we only estimate the earning equation without height. The coefficient of education becomes 7%. We argue that this coefficient also captures the effect of health. Therefore, we may overstate the return to education without controlling health status.

In order to examine the correlation between education and height, we ran a regression of years of schooling on height and the other control variables. The results are reported in Table 2.7. The coefficient of height from the OLS is 0.06, which means that years of schooling will increase by 0.3 years if height increases by 5cm. It is difficult to explain this coefficient as a causal effect linking height to education. Although it may be true that taller individuals are healthy and have better cognitive ability, they also tend to have more years of schooling. In general, both education and height may be affected by other common factors such as family income. However, this high correlation is consistent with our results that show, conditional on height, the return to education was reduced.

Table 2.7: Relationship between Education and Height (Dependent Variable is Education)

	OLS	
	Coef.	t
height	0.061	6.70
unemp	-0.449	-0.99
occup1	4.458	2.99
occup2	3.065	2.18
occup3	1.364	0.96
occup4	1.962	1.38
occup5	-2.083	-1.52
occup6	0.056	0.04
occup7	-0.926	-0.67
occup10	-0.745	-0.49
occup11	0.450	0.32
occup12	-0.463	-0.33

occup13	-0.519	-0.33
mary1		
mary2	-0.568	-0.18
mary3	-0.150	-0.05
mary4	-1.847	-0.56
mary5	-0.074	-0.02
mary6	-1.597	-0.48
age91yrs	-0.066	-0.96
agesq	-0.001	-0.87
gender	-1.166	-8.07
_cons	3.526	0.90

We also estimated equation (2-7) separately by categories of education. We classified education into four groups: no education, primary school, junior middle school and high school. It is obvious that instrumental estimates of return to height by education category are consistent but not efficient. The results are presented in the Table A2.2. The coefficient of height is 1.1%, 2.7%, 3.2% and 2.4% for groups with no education, primary school, junior middle school and high school, respectively.

From our empirical results, we reached the conclusion that height, which may measure the individual's strength and endurance at work, was indeed rewarded in the labour market in rural China[10]. The natural experiment method allows us to establish a causal effect between health and income. Combining the results from section 2.4, we conclude that the 1959-1961 famine in China had huge health consequences on the treated population, and this health effect resulted in significant reductions in earnings over the rest of life for those who survived the famine. As shown above, the annual income of

[10] It is said that height and occupation and height and marital status are potentially interrelated. In our regression, these variables have been controlled. The return to height is just a partial coefficient.

those who were born during the period of the famine is over 10 percent lower than it would otherwise have been if the famine had not occurred.

The Sample Selection

In this part we will discuss the sample selection problem. There are two sources of selection bias that may also influence the relationships between the intensity of the famine and subsequent height.

First, there was likely a substantial change in the composition of birth cohorts during the famine. The birth rate dropped by a third between 1958 and 1961 and then rose considerably in the years after the famine (Ashton et al. (1984)). The births that would otherwise have occurred between 1958 and 1961, but because of the famine did not occur, account for a larger proportion of population decline during the period than do death. Such a reduction is suggested by Figure 2.3 to 2.6, which indicate a smaller sample for people born in the famine years. If the parents who did not have children during the famine tended to be taller, then the average child born during the famine will tend to be shorter than the average child who would have been born in the absence of the famine. To address this selection issue, we need other data with information on the characteristics of parents who gave birth to children in each of these cohorts.

Second, there was substantial change in the composition of children conceived during the famine. The children who survived were likely to be the most healthy or those who came from better-off families. In addition, people affected by the famine are more likely to die in addition to being less healthy. The people who died during the famine leave the sample and can not be observed by the econometrician. This source of selection would tend to make the average surviving child taller than the average child who would have been born in the absence of the famine.

The bias from these kinds of sample selection could not be solved in our research [11]. But we can examine the direction of the bias. For the first selection, we tend to believe that the relatively wealthier people or physically stronger people are more likely to have child. According to the well established fact that there are close relationship between height and nutrition, we may conclude that the average child during the famine will tend to be taller than the average child who would have been born in the absence of the famine.
For the second selection bias, it is reasonable to believe that sample selection leaves only the most robust individuals in the sample. The estimate of effect of health is likely to be biased downward. It should be borne in mind that our method is likely to underestimate the effect of the famine.

2.6 Conclusion

The famine of 1959-1961 in China not only killed over twenty million people, but also dramatically damaged the health of survivors. We have estimated the impact on attained height by maturity, of cohorts of the population who survived the famine, using the difference-in-differences estimator. The result shows that the famine in China played a

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[11] Gorgens et. al (2002) has tried to overcome the problem from sample selection to estimate the effect on height of the famine.

significant role in reducing the attained height of individuals in certain cohorts, particularly in children aged 0-4 and adolescents in the 12-14 age group.

We then estimated the return to height using the famine as a natural experiment to deal with the omitted unobservable variable problem. The exogenous variation created by the famine allowed us to build a causal link between health and income. In the labour market in Chinese rural areas, height is clearly an important determinant of earnings. For each 1cm increase in attained height, the annual per capita family income will increase by about 3%.

If the assumptions underlying the empirical model are correct, our results suggest that health (as measured by height) yield a substantial return in rural China, and that a significant part of the effect of education on income appears to operate through health. The famine of 1959-1961 had a huge economic cost since health, in Chinese society, is substantially rewarded in the labour market. Our research suggests the following policy implications: (a) the famine may have imposed a huge life-cycle economic cost through its effect on the income of health; (b) health is a important element of human capital in the area of economic development. Therefore, societies would derive benefit from investing in the health of people, particularly in that of children.

In addition, our results potentially suffer from sample selection problems. If the sample selection leaves the most robust individuals in the sample, the estimates of the effect of health on labour market returns may be underestimated. The true effect of the famine for the whole population could be bigger.

Figure 2.3: Attained Height in 1991 for the Total Sample

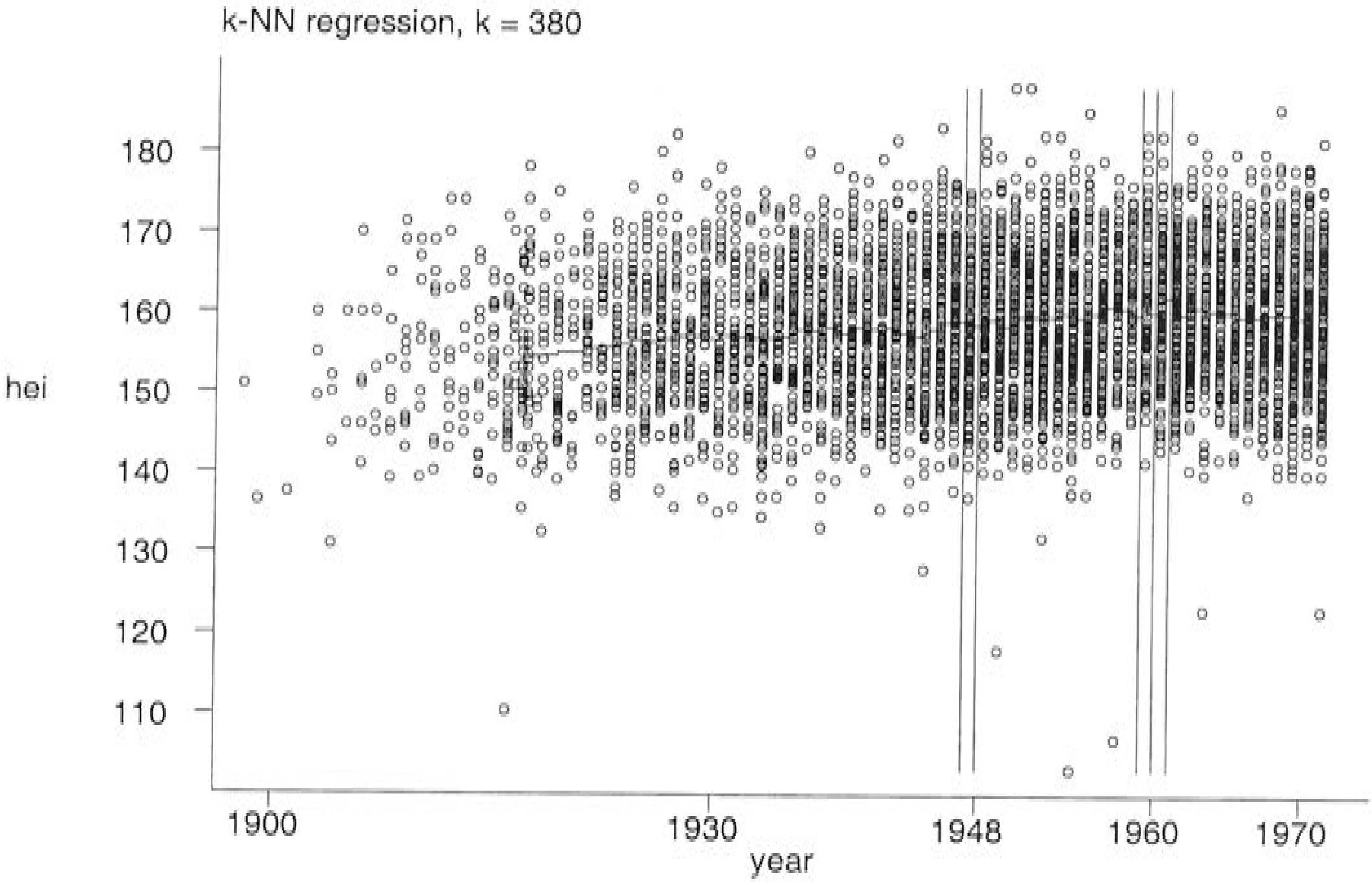


Figure 2.4: Attained Height in 1991 in Henan and Guizhou

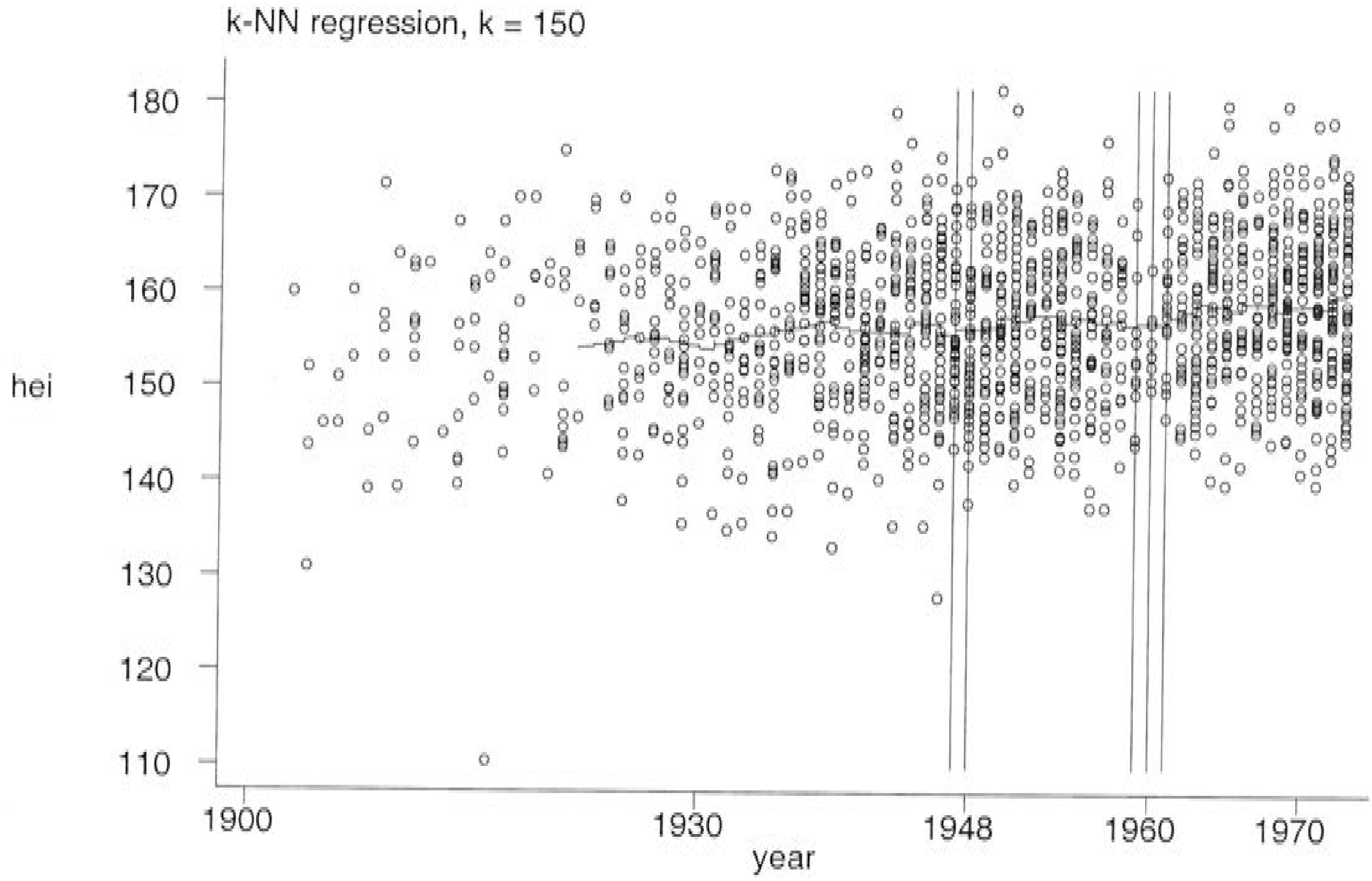


Figure 2.5: Attained Height in 1991 for Males in Henan and Guizhou

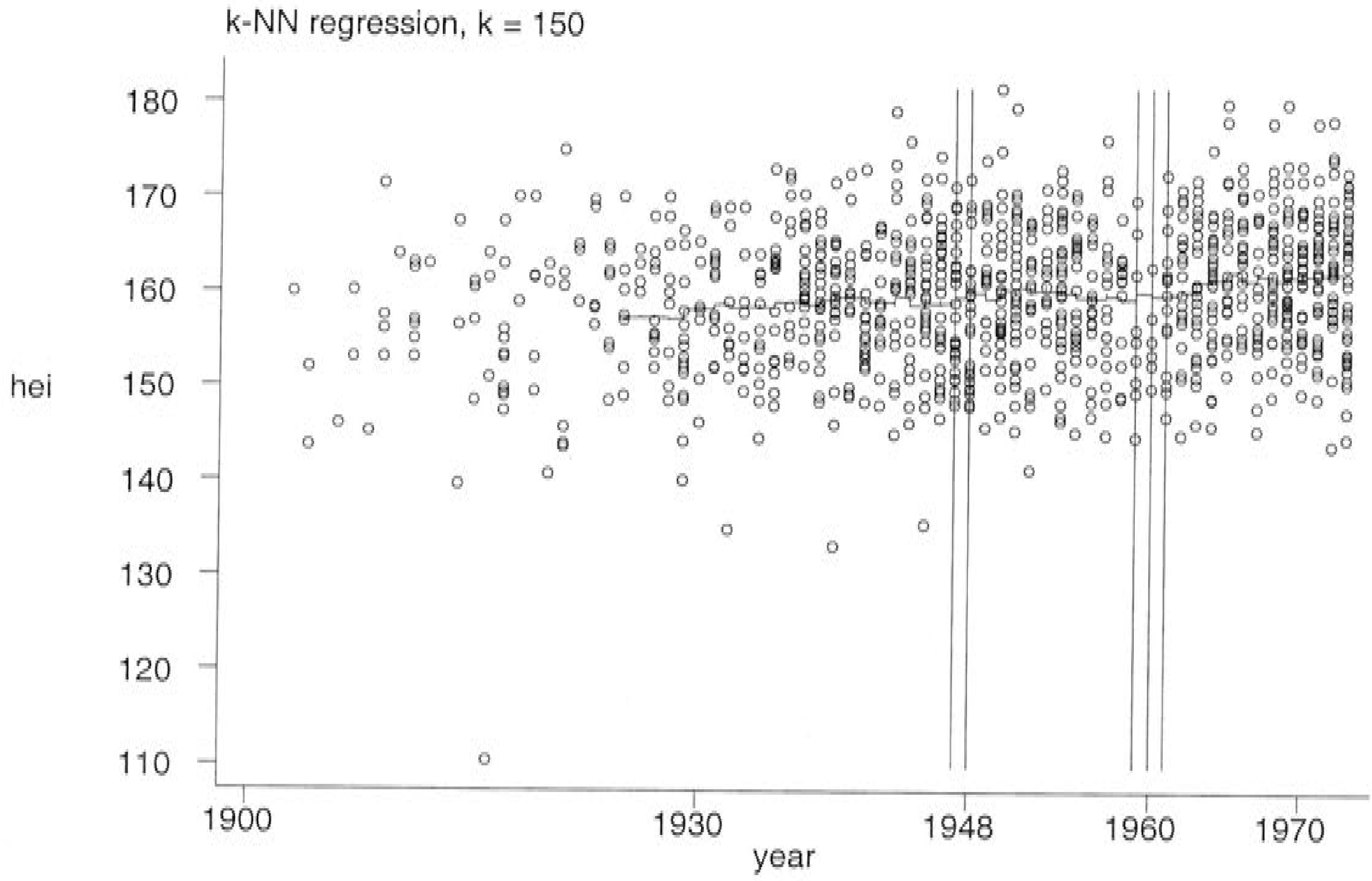
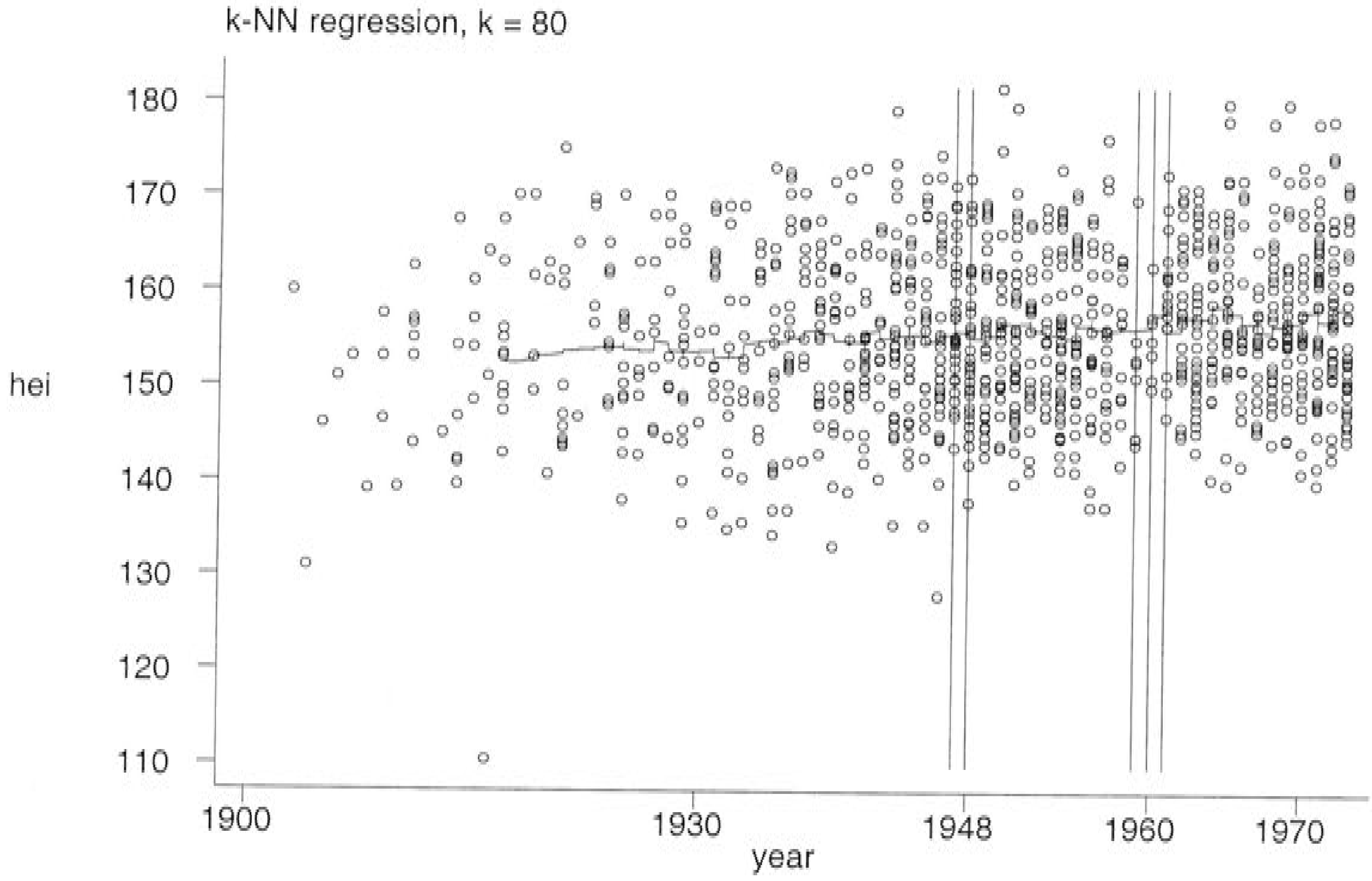


Figure 2.6: Attained Height in 1991 for Females in Henan and Guizhou



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2.8 Appendix

Table A2.1: Estimated Coefficient of Interaction of Age in 1961 and Excess Death Rate during the Famine

height in 91	Coef.	t
age 18	-4.107	-2.37
age 17	-0.421	-0.24
age 16	-2.738	-1.42
age 15	-1.335	-0.81
age 14	1.639	1.16
age 13	1.540	1.05
age 12	-1.092	-0.70
age 11	-0.381	-0.28
age 10	-2.911	-2.08
age 9	-1.962	-1.31
age 8	-0.059	-0.05
age 7	1.242	0.89
age 6	1.367	1.06
age 5	-0.842	-0.66
age 4	1.482	1.15
age 3	-0.336	-0.26
age 2	2.214	1.57
age 1	3.221	2.07
age 0	-1.118	-0.63
ddeath60	-0.134	-5.47
edr*age18	0.108	1.30
edr*age17	-0.061	-0.68
edr*age16	0.008	0.09
edr*age15	-0.034	-0.47
edr*age14	-0.153	-2.21
edr*age13	-0.163	-2.19
edr*age12	-0.084	-1.08
edr*age11	-0.019	-0.28
edr*age10	0.078	1.14
edr*age9	0.016	0.19
edr*age8	-0.056	-0.80
edr*age7	-0.109	-1.58
edr*age6	-0.133	-1.90
edr*age5	0.070	0.99

edr*age4	-0.186	-2.71
edr*age3	-0.010	-0.13
edr*age2	-0.223	-2.62
edr*age1	-0.265	-2.53
edr*age0	-0.004	-0.04
_cons	162.538	325.17
N	3435	
R sq	0.0682	

Table A2.2: Impact of Height on Income by Education Categories

	No education		Primary school		Junior middle school		High school	
linc	Coef.	t	Coef.	t	Coef.	t	Coef.	t
height	0.011	0.57	0.027	1.79	0.032	2.15	0.024	1.55
unemploy	-0.159	-0.46	-0.184	-0.81	-0.234	-1.40	0.938	2.58
occup1							0.695	1.29
occup2			0.149	0.20	0.410	0.70	0.576	1.13
occup3			-0.042	-0.06	0.638	1.10	0.619	1.20
occup4			-0.005	-0.01	0.744	1.28	0.593	1.14
occup5	-0.797	-1.01	-0.849	-1.42	-0.050	-0.09	-0.070	-0.14
occup6	-0.255	-0.27	-0.119	-0.19	0.683	1.21	0.684	1.33
occup7	0.060	0.08	-0.112	-0.18	0.587	1.04	0.590	1.14
occup8								
occup9					-0.089	-0.12	0.767	1.05
occup10			0.208	0.31	0.844	1.39	0.778	1.20
occup11			-0.270	-0.43	0.506	0.87	0.567	1.01
occup12	-0.267	-0.29	-0.028	-0.05	0.789	1.38	0.530	1.01
occup13			-0.005	-0.01	0.681	1.06		
mary1					0.909	0.81		
mary2	0.170	0.18	-0.015	-0.03	0.094	0.12	1.295	1.74
mary3	0.268	0.30	-0.110	-0.23	-0.013	-0.02	1.160	1.60
mary4			0.113	0.18				
mary5	0.716	0.77	-0.094	-0.18	-1.095	-1.26		
mary6	0.346	0.33			0.287	0.26		
age91yrs	0.003	0.07	-0.011	-0.38	-0.088	-2.72	-0.081	-1.41
agesq	0.000	0.20	0.000	0.66	0.001	2.93	0.001	1.67
gender	0.132	0.82	0.374	2.28	0.573	3.55	0.435	2.55
_cons	4.884	1.46	2.733	1.01	2.156	0.76	1.035	0.31
N	482		1321		1098		380	
R sq	6.6		9.16		13.49		28.04	

Table A2.3: Regression of Annual Per Capita Family Income

linc	no height Coef.	t	height (OLS) Coef.	t	Height (TSLS) Coef.	t
height			0.004	1.73	0.031	3.52
dpedu	0.090	2.09	0.087	2.03	0.069	1.56
djedu	0.145	3.08	0.139	2.95	0.100	2.00
dhedu	0.136	2.27	0.128	2.13	0.074	1.16
dcoedu	0.407	2.49	0.385	2.35	0.237	1.37
unemploy	-0.137	-1.10	-0.136	-1.17	-0.134	-1.13
occup1	0.276	0.71	0.297	0.77	0.440	1.11
occup2	0.214	0.59	0.231	0.64	0.349	0.94
occup3	0.311	0.86	0.324	0.89	0.415	1.12
occup4	0.346	0.95	0.362	0.99	0.471	1.26
occup5	-0.495	-1.41	-0.467	-1.33	-0.276	-0.76
occup6	0.324	0.91	0.341	0.96	0.458	1.26
occup7	0.255	0.72	0.276	0.78	0.415	1.14
occup10	0.537	1.39	0.554	1.44	0.664	1.68
occup11	0.145	0.40	0.168	0.46	0.321	0.85
occup12	0.305	0.85	0.330	0.92	0.500	1.35
occup13	0.162	0.40	0.197	0.49	0.435	1.04
mary2	-0.915	-1.10	-0.914	-1.16	-0.909	-1.13
mary3	-0.993	-1.26	-0.997	-1.26	-1.026	-1.28
mary4	-0.978	-1.16	-0.969	-1.15	-0.915	-1.07
mary5	-1.174	-1.47	-1.168	-1.46	-1.130	-1.38
mary6	-0.794	-0.93	-0.801	-0.94	-0.851	-0.98
age91yrs	-0.043	-2.45	-0.044	-2.48	-0.048	-2.65
agesq	0.001	2.82	0.001	2.87	0.001	3.15
gender	0.152	5.26	0.194	5.16	0.471	4.94
_cons	8.335	9.19	7.604	7.60	2.715	1.47
N	3312		3312		3312	
R sq	17.56		17.64		14.27	

Note: in this table, the categories of education are used rather than years of schooling as independent variables.

Chapter 3

Eating Your Way up the Food Chain: Female Health, Productivity and Food Allocation in China

3.1 Introduction

The rate of agricultural output in China grew very rapidly during the 1980s due to the introduction of a new family based production system (Lin 1992). With development of the agricultural sector, living standards of rural residents improved dramatically. Since wellbeing or living standards are characteristics of individuals, not households, we need to understand how resources are allocated within families in order to measure wellbeing. Do women benefit from economic development to the same extent as men? Are resources, such as food, distributed equally amongst family members, taking individual needs into consideration? Is resource allocation within family affected by the relative bargaining power of each family member? Furthermore, under a family based agricultural production system, if labour market productivity positively correlates to health status, does this linkage affect the allocation of food within the family? Is it true that individual health contributes to productivity?

The conventional literature on food allocation within the family postulates that the family planner will allocate resources such that the marginal utility of health amongst individual members will be equal (taking into account the family's preferences). In this kind of model, available food will be allocated to achieve equal marginal utility of individual health. The food allocation pattern implied in this model suggests that a member with a better health endowment might receive less food since the marginal utility of health, from this member, is comparatively lower than the marginal utility of health from one with worse health status.

Increasingly, empirical evidence indicates that the allocation mechanism within the family may be a very complex process. A large number of studies (Dreze and Sen 1989; Harriss 1990; Dasgupta 1993), are concerned that the allocation of household resources favours males over females. Thomas (1994) documents a positive association between a mother's education and her daughters' height and a father's education and his sons' heights. Alternatively, the household might be thought of as a group of individuals who bargain with each other over resources. The consequences of this assumption have been examined in the literature by (Manser and Brown 1980; McElroy and Horney 1981; Lundberg and Pollak 1993).

In this chapter, we focus on food (nutrition) allocation within the family in the framework of the common preference model. We consider the assumption that a linkage exists between individual productivity and individual health status within the framework of the common preference model. In this type of model, the family planner attempts to allocate food among individual members to achieve equal marginal utility from food for the individual member with the shadow price of the food. The most important feature of the model which considers the link between productivity and health is that the shadow price of food is reduced through the mechanism that health augments work efficiency. In this model, the family planner considers two possibilities when allocation decisions are made. The first possibility is that the planner tries to equalise marginal utility amongst family members. Under the second possibility, food is allocated in relative quantities so that more food is made available to those members whose health augments work efficiency. The first choice suggests allocating less food to those members with better health endowment. The alternative choice suggests allocating more foods to those persons with better health endowment "because food increases health, which increases the return to effort and, because effort depletes health status, increased food consumption both compensates for and enhances the return from increased effort"(Pitt, Rosenzweig and Hassan1990).

Economists and policy makers may be interested in the disparity between the quantity of nutrients received by women compared to men. Some research suggests that the return, to a household, from the allocation of food to women is less than that for men. This gender biased nutrient inequality reflects disparities in labour market opportunities between men and women. Pitt et al. (1990) pointed out that if the relationship between healthiness and productivity differs across activities, the distribution of activities across individuals within gender classes should also be related to the intra-household distribution of food.

Basically, those individuals exerting greater effort or engaged in effort intensive activities will be allocated more food. Pitt, Rosenzweig and Hassan found that the elasticity of nutrition demand, with respect to individual health endowment, is lower (insignificant from zero) for women in Bangladesh than that for men because women are usually barred from participating in activities in which health status strongly affects productivity.

In this chapter, we will examine the above issues in the context of China. Firstly, we estimate the health production function. And the effects of nutrient intake and work effort on health status are examined. Nutrient intake is believed to improve one's health status and work effort to deplete health. Then these estimated health production are used to derive the health endowment. The health endowment is defined as the component of health status that is influenced neither by calorie intake nor by work effort.

Using the derived health endowment, we estimate the calorie consumption equation. And we try to examine the effect of health endowment on individual calorie consumption. This allows us to understand how the food is allocated within the family. We finally examine the relation between health endowment, work effort and the wage.

Table 3.2 describes the distribution of activities by sex in China. Activity is categorised into five groups. We found no great differences between man and woman in the distribution of activities except for the category "very heavy physical activity". It is worth noting that the proportion of women participating in heavy activity is slightly greater than that of men. This distribution pattern of activities reflects the fact that women have played an increasingly more important role in agricultural production in rural areas of China since the 1980s.

Table 3.3 describes the distribution of health status and energy requirements by activity and sex. This table suggests that the heavier the activity, the more energy is required, both for man and woman [12]. Obviously, the Body Mass Index (weight divided by height squared), which is thought of as a good health status indicator, is not increased with the consumption of energy. This suggests that the combinations of activity and food consumption determine health status.

This also suggests that there is a relationship between activity and intra-household allocation of nutrients. We will examine intra-household food allocation considering the linkage between productivity and health and individual heterogeneity in endowed healthiness, following the framework of Pitt et al.

Why this research?

Firstly, since health, like schooling, is a form of human capital, we can expect it to correlate to labour market success. Although there have been substantial advances in our understanding of the interrelationships between health, food consumption and economic performance, this issue has received much less attention in the empirical literature. To the best of my knowledge, there is no research on this issue related to China.

Secondly, resource distribution within the family is ignored by most research concerned with inequality. If there indeed exists a compensated effect of food allocation among

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[12] The question designer expects Activity 3 to require more energy than activity 2. However, the data suggests that this order may be reversed.

family members, woman and children, who are usually physically weaker than adult males, will suffered more from any inadequacy in food supply in a low income economy. Some government and planning policies are needed to protect these vulnerable groups from starvation.

Thirdly, knowledge of the link between health and labour market outcomes is also important for policy makers. The evaluation of health sector investment needs to consider the direct benefits of increased investment in health in terms of higher productivity.

Finally, It seems that the wellbeing of the poorest members of the community is enhanced more by some health sector investments than others. Women and children may benefit more from government health policy when they are discriminated against within the family (because of the reinforcement effect).

This chapter includes five parts. Section 3.2 is a literature review. Section 3.3 documents the institutional background in China and the data used in this chapter. Section 3.4 is the model. Section 3.5 reports the estimation of the health production function. The effect of health status on calorie consumption is discussed in section 3.6. Section 3.7 examines the links between health status and labour market productivity. A brief conclusion makes up section 3.8.

3.2 Literature Review

We draw two threads from the literature i.e links between productivity and health and intra-family resource allocation. It has been a long time since the potential relationship between nutritional intake and labour effort per unit of time attracted the interest of economists and nutritionists. Economists have been interested in how labour markets might adapt to the relationship that spawned the *efficiency wages hypothesis.* Many theoretical works have been developed on this topic (Stiglitz 1976; Gersovitz 1983; Dasgupta and Ray 1986; Dasgupta and Ray 1987 and Strauss 1986). An important issue taken up in this research, is the direction of causation, that is the attempt to answer the question of whether the link runs not only from income to nutrition but also from nutrition to income. A number of works have attempted to test the relationship between nutrition and productivity. Amongst these, most notably a study of Sri Lanka by Strauss (1986), found a highly significant correlation between calorie intake and labour productivity. Behrman and Deolaliker (1989) also noted the significant effect of nutrition on productivity. Strauss and Duncan (1998) give a wonderful review in this field.

The other thread in the literature relates to resources allocation within the family. How are resources allocated within the family? Recently, this question has attracted much attention from economists and in the literature two types of models are considered. The first is the common preference model (Becker 1981), in which resource allocation is treated as the outcome of maximizing a well-behaved household welfare function. In this model, the mechanism underlying the resource allocation process is ignored.

McElroy and Horney (1981) propose alternative models of household decision making. The resource allocation process is specified as the equilibrium of a Nash bargaining game. The weighting of allocation within the household will then depend on variables reflecting the outside option.

Recently there has been a resurgence of interest in these models (Chiappori 1988; Chiappori 1992; Browning, Bourguignon, Chiappori and Valerie Lechene1994; Browning and Chiappori 1998) with researchers using a series of testable restrictions derived from the general collective model. In this type of model, only the assumption of Pareto efficiency is imposed. No restrictions are imposed on the underlying decision process.

Economists are interested in whether there is evidence of gender bias. It has been determined that infant and child mortality in India is lower among boys (Rosenzweig and Schultz 1982) and there are many studies indicating that boys may be favoured in the allocation of resources within the family (Behrman and Deolalikar 1989). Duncan Thomas found that there are differences in the allocation of household resources depending on a child's gender and these differences vary with the gender of the parent (Thomas 1994).

Recognising that behaviour at income levels near the subsistence level may be very distinct from that observed when income levels are higher, Pitt, Rosenzweig et al. (1990) proposed a model incorporating linkages between nutrition, labour-market productivity, health heterogeneity, and intra-household allocation of food in a subsistence economy. This study focused on the relationship between intra-household distribution of food and the distribution of activities across individuals, given that the linkage between healthiness and productivity differs between activities. The findings suggest that households are averse to inequality. Pitt et al conclude that the low variance in calories consumed by women relative to men in Bangladesh, reflects the limited participation by women in activities in which productivity is sensitive to health status. Since women are usually prevented from attending energy-intensive activities in which health may strongly augment return to effort, the estimated elasticity of calorie consumption by women with respect to health endowment (how to calculate health endowment will be discussed in the following section) is lower than that of men and is statistically insignificant.

Unfortunately, there are very few studies pursuing Pitt et al's rationale, primarily because of the lack of data. In this research, we will use a very rich data set from China to study resource allocation within the family and we take the linkage between labour market productivity and health status into consideration. According to the model formulated in Pitt et al 's paper, the estimated elasticity of calorie consumption for women, with respect to health endowment, should be greater than that of men and will therefore be statistically significant. This is because, in rural China, more women have been involved in farm work than men since the introduction of the family based agriculture system and the rise of township and village enterprises in the 1980s. This has meant that on average women are now involved in more energy intensive activities than men and these activities are rewarded in the labour market.

3.3 Background and Data

3.3.1 Background

In the 1980's, the role of women in rural China changed dramatically (see Table 3.2), due to the fact that a large proportion of women undertook responsibility for much of the heavy physical labour on family farms. These changes were driven by the two forces of supply and demand.

In 1979, a new agricultural system called the "Family Responsibility System" was introduced in China. Under this system, land was distributed equally among households within rural villages. At the same time, the rise of Township and Village Enterprises (TVEs) demanded a huge number of workers. In these circumstances, male family member (husbands) went to work in the TVEs while the women (wives) were required to perform the farm work previously done by their husbands. Our data shows that the number of male workers in the TVEs was twice that of female workers.

Lin (1992) clearly shows that agricultural output increased dramatically in the early 1980s due to the right incentive mechanism. There is also some historical evidence showing an increase in food consumption at this time. We believed that this increase in agricultural output improved the nutritional status and health of the population, particularly that of women. Women with better nutrition status are better equipped to undertake the physical heavy activity required of agriculture production.

Following the principle that the changing role of women in rural China would affect food allocation within family, within family allocation decisions are of interest and very important. Many Chinese rural households still cope with a standard of living near subsistence level with our data showing that the sample mean per capita income in 1989 was 987 RMB (about one dollar per day). Resource allocation behaviour at low income levels may be quite distinct from that observed when income levels are well above those required for survival. For instance, the family may try to allocate limited food resources in the most efficient way by taking into consideration the productivity and activity levels of each individual member.

The real-life saga of the poor household in rural China is a kind of *life boat* story. All family members need to cooperate in order to maximise their utility. This becomes interesting when links between productivity and health status are considered from the perspective of the process of food allocation within the family. In the following sections, we will examine how health status affects the distribution of calories. There is little research on the existence of a relationship between intra-household food allocation across individuals and labour market activities. Our observations on the rural labour market in China suggest that issues of within gender inequality are worthy of more attention. Healthier women are able to participate in activities where health augments returns from effort, therefore these women may receive a greater food allocation to compensate for and enhance the returns realised from their increased effort. However, women who are in poorer health (as well as children) may be allocated less food because limited resources are allocated to persons who can earn more. While an increase in labour force participation by women would likely increase the quantity of calories allocated to some women it would also increase inequality between adult women (i.e. within-gender inequality).

3.3.2 Data

We use panel data from the China Health and Nutrition Survey (CHNS). The general description of the data set can be found in Chapter 2. The data includes rich information about individual health, nutrient intake and other social-economic variables.

Nutrition intake data is available only for 1989 and 1991. All individuals in each household were surveyed in 1991 and 1993, however, in 1989, health and nutritional data was only collected from preschoolers and adults. In this chapter, the main data used is from the survey conducted in 1991. Information from the 1989 survey is used to create instrumental variables. Because our focus is on the population of rural areas, all observations from urban areas have been dropped. Individuals aged 10 years or less have also been dropped in our estimates of the health production function and the calorie consumption function.

Table 3.1 presents the descriptive statistics. The variables measuring health include daily calorie intake, height, weight, constructed body mass index (BMI), triceps skin fold, and upper arm circumference.

3.4 The Model

To understand food allocation within the family, we consider three models.

3.4.1 Common Preference Model without a link between health and productivity

In this model, we assume that there is no link between labour market productivity and health status. The family planner maximises a family utility function subject to the family's budget constraints. We assume that the family planner cares for each family member's health, and that health is a function of food consumption, working effort and health endowment.

The health production function may be written as:

$$H_i = H(C_i, E_i, \mu_i; Z), \tag{3-1}$$

where H_i is the measure of health status of family member *i*, C_i is consumption of family member *i*, E_i is the working effort which is thought to delete health status. μ_i is health endowment which is thought of as the component of health influenced by neither food consumption and work effort. Z represents other individual characteristics and environmental variables that determine health status.

We may write the family planner's problem as follows:

$$\text{Max } U = U(H_i, C_i; X, \mu_i) \tag{3-2}$$

$$\text{s.t. } V + \sum W_i - P\sum C_i = 0, \tag{3-3}$$

where X is a vector of demographic characteristic variables, V is the non labour income of the family, W_i is wage of member i, P is price of the consumption. We assume that individual family members in-elastically supply one unit of labour. This assumption is quite reasonable because there is little tolerance for a lazy person in a poor economy.

The first order conditions of this problem tells us that the family will equate the marginal utility from food consumption of individual i to the market price of the food. Because the market price of food is the same for all family members, the family will equalise marginal utility of food among individual members.

Assuming that the health production function is the same among family members and the utility function is concave, static comparative analysis suggests that members with better health endowment will get less food since the marginal utility of food for him/her is relatively lower than it is for others. Basically, this toy model predicts that the family planner really avoids inequality among family members. Some research suggests that families at times appear not to allocate resources equally. This observation motivates further development of our theoretical model. One direction that this development may take is to try to understand food allocation within the family by introducing the linkage between labour market productivity and health status. A second direction would be concerned with bargaining processes within families.

3.4.2 Common Preference Model with a link between health and productivity

The development economist has observed the linkage between health and productivity. Let us assume that health and effort are rewarded in the labour market, and returns to effort increases with health status. We may write the wage rate function as follows:

$$W_i = W(E_i, H_i). \tag{3-4}$$

We assume $\frac{\partial W_i}{\partial E_i}, \frac{\partial W_i}{\partial H_i} > 0$, and $\frac{\partial^2 W_i}{\partial E_i \partial H_i} > 0$. These assumptions mean that wage is an increasing function of effort and health status. In addition, the marginal return to effort increases with health status. Equation (3-4) and the health production function (3-1) capture the essential assumptions of nutrition-wage literature.

With the linkage between health and wages, the family's problem may be written as:

$$\text{Max } U = U(H_i, C_i, E_i; X, \mu_i) \tag{3-5}$$

$$\text{s.t. } V + \sum W_i - P\sum C_i = 0, \tag{3-5'}$$

and the health production function (equation (3-1)) and wage function (equation (3-4)). We assume that individual health status and food consumption increases the family's utility function and effort decreases it.

The first order conditions are:

$$\frac{\partial U}{\partial H_i}\frac{\partial H}{\partial C_i} + \frac{\partial U}{\partial C_i} = \lambda\left(P - \frac{\partial W}{\partial H_i}\frac{\partial H}{\partial C_i}\right) \tag{3-6}$$

$$\frac{\partial U}{\partial H_i}\frac{\partial H}{\partial E_i} + \frac{\partial U}{\partial E_i} = -\lambda\left(\frac{\partial W}{\partial E_i} + \frac{\partial W}{\partial H_i}\frac{\partial H}{\partial E_i}\right) \tag{3-7}$$

From the first order conditions, it is clear that the family planner will equate the marginal utility of food (effort) to its shadow price. Look at equation (3-6), the left hand side represents the marginal utility achieved by the family from an additional unit of food consumption by individual *i*, the right hand side of the equation (in parenthesis) is market price minus the value of wages increased by the food consumption through health. Since health augment an individual's wages, the shadow price of food is lower for the person with better health endowment.

Food and effort allocation within the family are determined from the first order conditions (equation (3-6) and (3-7)). Here, the question of interest is "how does the allocation of food and effort respond to changes in health endowment". Using the total differentiated equation (3-6) and (3-7) with respect to μ, we may produce the following:

$$\frac{dC_i}{d\mu_i} = (P - \frac{\partial W}{\partial H_i}\frac{\partial H_i}{\partial C_i})(\frac{\partial H}{\partial C_i})^{-1}(-\frac{\partial^2 H}{\partial C_i}S_{cici} + \frac{dC_i}{dV}) - S_{ciEi}\frac{\partial^2 W}{\partial E_i H_i} + \frac{dC_i}{dV}\frac{\partial W}{\partial H_i} \qquad (3\text{-}8)$$

where S_{CiCi} and S_{CiEi} are Hicks own substitution effects (negative) and cross substitution effects (negative if effort is "bad"), respectively. In equation (3-8) the first item in the right hand side is negative. This means that family member with higher endowed health status will receive less food if the income effect is small compared to the substitution effect. We call this the equalisation effect because higher health endowed members are taxed while low health endow individuals are compensated with more food. The last two items capture the interaction of health and effort in the labour market, which are both positive factors. We call this a productivity effect. This effect indicates that a person might be allocated more food if he/she participates in activities in which health augments the return to effort most directly. However, we cannot judge from the theory the sign of $\frac{dC_i}{d\mu_i}$ because the equalisation effect and productivity effect generate opposite outcomes. The primary focus of this chapter is to use micro data to examine the effect on food allocation of personal health endowment.

Pitt etc al.(1998) conducted a comparative exercise for a model using an income maximisation assumption. In the income maximisation model, both food allocation and effort of individual i respond positively to health endowment. The propositions are simple. Higher health endowment will increase return to effort, and effort depletes health. Family members need to be allocated more food to compensate for additional energy expended and enhance increased effort.

3.4.3 Bargaining Model

The assumption of a "unitary household" may be too restrictive. Some efforts have been done to model family decision processes because households can be thought of as a group of individuals who bargain with each other over resources. The consequences of this assumption have been examined in the literature (Manser and Brown 1980; Lundberg and Pollak 1993; Browning and Chiappori 1998). These researchers have developed a methodology that assumes that family resource allocation is Pareto optimal. This permits empirical testing of their predictions.

Given the health production function (3-1), the wage function (3-4) and budget constraints (3-5'),

the Pareto-efficient allocation of resources within the family solves as:

$$\max \sum_{i=1}^{N} \lambda_i U_i(C,H,E)$$

s.t. equation (3-1), (3-4) and (3-5').

Where U_i is the utility function of family member i, which depends on the consumption, health and effort of individual i. N is the total number of family members, C is a vector of food consumption by each family member, H is a vector of health status of each family member, and E is a vector of effort for each family member.

The family decision process can be divided into two stages. In the first stage, family members share non-labour income according to a sharing rule. We called this λ, which is a function of the factors reflecting the bargaining power of individual members. In the problem under investigation, λ is a function of health endowment.

At the second stage, individual i maximises the following problem:

$$Max\ U_i(C,H,E)$$

s.t. $PC <= W_i + \lambda(\mu)V$

and wage function (3-4) and health function (3-1).

It is obvious that food consumption by individual i is a function of λ, hence μ. If the sharing rule is an increasing function of personal health endowment, this will increase the individual's total income. Food consumption will also be increased. We call this the bargaining effect of health endowment. In this problem, the marginal utility from the last unit of food equals the shadow price. The comparative analysis is similar to the unitary model above except that we have incorporated the bargaining effect.

3.4.4 Specifications

In this chapter, we are interested in how the distribution of activities affects food distribution among family members when there is a linkage between health and productivity. If there is a big difference in the distribution of activities between genders, food allocation will also differ to reflect the extent to which health augments return to effort. In South Asia, women are not allowed to participate in activities in which health status strongly affects productivity and we expect to observe a different elasticity of food consumption with respect to personal health endowment.

In China, the distribution of activities between genders is very similar. However, within gender classes, the distribution of activities is an important factor when it comes to food allocation. We expect to see that there is no great difference in the elasticity of food consumption with respect to personal health endowment between genders.

Initially, we need to estimate a health production function.

$$H_i = \alpha + \beta C_i + \gamma * Activity_i + X\delta + \varepsilon_i \qquad (3\text{-}9)$$

where C_i is calorie consumption by individual i, *Activity* proxies the effort of individual i, X represents other control variables such as individual characteristics and environmental variables. We define health endowment as the component of health influenced by neither calorie consumption nor effort.

We derive an estimate of health endowment after estimating health production (3-9). We can then examine the effect of health endowment on the allocation of calories for individual consumption using the equation:

$$C_i = a + b * healthendowment + Zc + error \tag{3-10}$$

where Z represents control variables such as individual characteristics and family characteristics.

We also need to examine how productivity or effort is affected by health endowment. The following equation may be used for this purpose:

$$Y_i = \alpha + \beta * healthendowment + \gamma * controls + error \tag{3-11}$$

where Y_i is a dummy for activity or wage. We expect that, in rural China, health endowment is positively related to heavy activity and wages are the returns of energy and physical strength which are rewarded in the traditional agricultural sector.

3.5 Heath Production

In this part of the study, health production (3-9) will be estimated using the body mass index (BMI) as a measure of health. BMI equals weight (kg) divided by squared height (m). How to measure health is a difficult question since health is multi dimensional. It has been suggested that anthropometric measurements such as height and weight are less subjective indicators of health status. Both height and weight are believed to be related to productivity. However, tall people may also be slight and overweight people may not be productive. For these reasons it may be convenient to analyse weight in relation to height. While different ways of expressing this ratio is possible, BMI is the most frequently used index (Thomas and Strauss 1997). Basically, BMI is a measure of health in the short run and may be affected by food consumption and effort[13].

In equation (3-9), nutrition intake is measured by calorie intake. To reflect calorie outflow, we use dummy variables to indicating participation in activities classified as moderate heavy activity, heavy activity and very heavy activity.

Individual characteristics such as age, age squared, gender dummy, interaction of gender and age, were controlled. To avoid omitting variable bias, we have tried to control

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[13] It is argued that very high and very low values of BMI (being too obese and being too thin) are indicators of bad health. So in the research of effect of BMI , we need to include the squared BMI in the regression to reflect this fact. In this chapter we estimate a health production function and from which to derive the health endowment. We don't need to consider this kind of non linear relation between BMI and observed health.

environmental characteristics such as water source, categories of floors and if a dwelling place is clean or dirty.

Obviously, calorie consumption and activities in health production are endogenous and therefore the OLS estimator will be biased. 2SLS will be used to obtain a consistent estimator. The key to this phase of the study is to find valid instrumental variables. The instrumental variables chosen should affect health status only through calorie intake and work effort. Our rich data set offers us several exceptionally appropriate instrumental variables. We have used the following variable as instruments: a dummy for households with professional cooking equipment, a dummy for household's with poultry, and food prices such as rice, flour and noodles, vegetables, eggs, pork, fish and beans, and age and years of schooling of the head of the household. The dummy for households with professional cooking equipment and a dummy for household's with poultry may correlated with calorie consumption. A household with professional cooking equipment may have good knowledge about nutrition. And a household with poultry also have chance to take more nutrition. These two variables affect health only through nutrient intake rather directly. The prices of various foods obviously will affect health only through food consumption. Age and years of schooling of household head could be valid instrumental variables because these characteristics may correlated with individual's activity and not affecting family member's health.

If a household has professional cooking equipment, nutrient intake will be directly affected because the family may have more knowledge about health and may produce nutrients more efficiently. However, there is no reason to believe that because a household has professional equipment, individual health will be affected directly. It is widely accepted that the price of food is a valid instrumental variable for calorie intake. The age and years of schooling of the household head and the above mentioned instrumental variables are used to instrument activity choice.

The results are reported in Table 3.5.1. The OLS estimate of the coefficient of calorie consumption is 0.046 and this is statistically significant. The coefficients of activities have correct signs and are significant for moderate heavy activity and heavy activity. The estimate of the coefficient of calorie consumption using 2SLS is 0.174, which is much higher than OLS estimates.

The OLS estimate bias is downward compared to IV estimates. This is consistent with our theory. Increased intakes of nutrient will improve health status. However, better health will also make an individual more likely to engage in energy consuming activities that in return deplete health. As a consequence, health may not increase as much as it might be in the absence of the increased effort.

Table 3.5.2 presents the 2SLS results of the health production function by gender. The results are not very much different from those in Table 3.5.1 except that the coefficient of calorie consumption for females is not significant. The variables of activity have the correct signs. The results suggest that males and females in Chinese rural areas may share the same health production technique.

We also examine health production using alternative measurements of health status. Table 3.5.3 presents the results using arm circumstance and skin fold as dependent variables.

Obviously, calorie consumption improves an individual's health status and physically heavy activities deplete one's health. Food allocation within the family needs to balance calorie intake and calorie outflow due to work effort.

From our estimate of the health production function, we can derive an individual's health endowment influenced by neither calorie intake nor effort. This estimate of health endowment will be used in the next section to examine the effect of health endowment on calorie distribution.

3.6 Intra-household Calorie Allocation and Health Endowment

In this section, equation (3-10) will be estimated. We rewrite it as follows:

$$C_i = a + b * healthendowment + Zc + error \tag{3-10}$$

where *healthendowment* is calculated from the above section. Z is a vector of variables to control individual and family characteristics.

To estimate equation (3-10), *healthendowment* needs to be instrumented if there are measurement errors for calorie intake. Recall that our estimated health endowment μ_i is calculated using:

$\mu_i^* = H_i^* - C_i^* A$,

where the star symbol means true values for the variables, A is the coefficient of calorie consumption. Suppose that health status and nutrition are measured with errors. We can write:

$$H_i = H_i^* + u_i$$

$$C_i = C_i^* + e_i$$

where the error items are not correlated with the true values. The estimated health endowment is:

$$\hat{\mu}_i = (H_i^* + u_i) - (C_i^* + e_i)\hat{A}$$

$$= \mu_i^* + U_i - e_i\hat{A}.$$

we are interested in the estimation of the following equation

$$C_i = a + b\hat{\mu} + e_i.$$

It is easy to show that

$$P\lim \hat{b} = b\frac{\sigma_{\mu\mu}}{\sigma_{mm} + \sigma_{vv}} + \frac{\sigma_{ev}}{\sigma_{\mu\mu} + \sigma_{vv}}.$$

That is, the estimation of the coefficient of health endowment in equation (3-10) will not be consistent if measurement errors are present. The suggested method of dealing with the classical measurement error problem is 2SLS.

The instrumental variables used to account for the measurement problems in health endowment of 1991. We are assuming the measurement errors in different years and in different variables two waves are independent. In addition, skin fold thickness and arm circumference are obviously correlated with BMI.

Table 3.6.1 includes the 2SLS result for equation (3-10). All variables are in log except for the dummies. The elasticity of calorie consumption with respect to personal health endowment is 0.23. The person with higher health endowment will receive a greater food allocation to enhance his/her productivity and compensate for his/her effort. This finding suggests that the productivity effect is the key factor in the process of deciding food allocation within the family. A person might be allocated more food if he/she participates in an activity in which health augments the return to effort most strongly.

We may wish to further determine if there are differences between men and women in the elasticity of calorie consumption with respect to personal health endowment. In rural China, under the "Family Responsibility System" initiated in the early 1980s, more and more women have participated in farming activities where health status strongly augments return to effort. Coincidently, since the mid 1980's, men have increased their participation in Township and Village Enterprises, working off the farm for wages. The role of women in farming became more important when they needed to take over the farm work previously done by their husbands. It is clear that farm work in rural China is one activity in which health status strongly augments return to effort. Table 3.2 shows the distribution of activities by gender, with the data showing 53% of farm workers being male and 56% female. Women play a major role in farming in rural China.

Our theory predicts that the elasticity of calorie consumption with respect to health status should be higher for women than for men, or should at least be at the same level. We estimated equation (3-10) by gender and the results are presented in Table 3.6.2. We used the same control variables and instrumental variables used in Table 3.6.1. The coefficient of personal health endowment was calculated to be 0.21 and 0.39 for men and women, respectively. As anticipated, women received more food when their health endowment was higher because of their increased role in farming.

The cross effect of health endowment of other males and females in the household was negative but not significant. The negative sign of the cross effect may suggest that the income maximisation model should be rejected. Certainly, we cannot derive concrete conclusions from these insignificant estimates.

In summary, the findings in this section may help us to understand the mechanism of food allocation within the family unit in rural China. The introduction of the family based farm ownership scheme and the rise of rural industry allowed females to play a more important role in farm work where health effort strongly augments return to effort. Under these circumstances, women seem to be allocated more food in order to enhance their health and to compensate for their effort. Although we cannot say whether the net welfare of women has increased or not, it is believed that the increasingly important role played by women in agricultural production enhances their bargaining power in determining resource allocation within the family. We won't pursue these issues further in this Chapter.

3.7 Productivity and Health

Our logic about family resources allocation may be expressed as follows: health distribution → activity distribution → food distribution → health distribution. In this study , the key component is that health augments return to effort. In this section we will examine this link.

Our theory implies that health endowment is positively correlated with individual income or wages, and that individuals with better health endowment are more likely to participate in labour intensive activities where energy is demanded.

We firstly examine the effect of health endowment on activity choice. Physical strength is essential to undertake farm work in rural China, given the low level of mechanisation. As shown in Table 2, after 1980, more women are involved in heavy activities. We propose that this is the consequence of two forces. One is that the health status of women improved dramatically in the 1980s. In other words, women become physical stronger which gave them the capability to undertake heavier activities. The other force is a response to demand. Wives were required to finish farm work that had previously been undertaken by their husbands, after their husbands had moved into the rural industry sector.

Table 3.7.1 presents the results of the effects of health endowment on activity choice. The dependent variable is a dummy which indicates that a person undertakes heavy and very heavy activities. Individual characteristics such as age and sex have been controlled. We also include land size in the regression so that our results can be interpreted as being conditional on land holding. Household characteristics were also controlled. The regression has been estimated using Two Stage Least Square [14]. Personal health endowment has a significant effect on the probability of individuals engaging in heavy activities. Interestingly, the coefficient of sex is negative (not significant), this indicates that more males are involved in relatively less heavy activities.

Secondly, we try to examine the effect of health endowment on per capita family income. Consider a family with a physically strong wife. The husband of this family may be able to move easily into the rural industry sector since his wife will finish his farm work. This may imply that personal health endowment will increase household income. Furthermore, the effect of health endowment on family income might be greater for females than for males. An increase in female health status has two effects on family income: increased productivity from higher health status, which in turn allows their husbands to engage in the rural industry sector to earn money.

Table 3.7.2 reports the results for determinants of per capita family income by sex. Individual family characteristics have been controlled. Here the effects of personal health endowment are significant for both males and females. As we expected, the effect for

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[14] We use a bootstrap method to estimate the asymptotic standard error for the estimated coefficient.

females is greater than that for males. The elasticity of per capita family income with respect to personal health endowment are 1.37 and 0.61 for females and males, respectively. The effect on income of improved health endowment for females is twice that of males. These results suggest that improvement in female health status is of significant benefit in increasing family income.

3.8 Conclusion

In this chapter, the calorie consumption distribution within the family has been examined taking into consideration links between productivity and health status in China. We firstly estimate a health production function, and then calculate health endowment, which is the component of health influenced by neither calorie consumption nor work effort. We then examine the effects of personal health endowment on calorie consumption. We also examine the effects of health on activity choice and family income.

Our results suggest that health endowment indeed affects calorie consumption distribution within the family in rural China and this effect is greater for females compared to males. This reflects the fact that females have played an increasingly important role in farm work while males pursued job opportunities in the rural industry sector where they can earn more money. In order for husbands to be free to work in the industrial sector, it became necessary for their wives to be capable of undertaking heavier work. Women who had better health endowments and were strong enough to replace, at least partly, their husbands' role in farming, were allocated more calories to compensate for their efforts. However, women with poorer health may have received fewer calories because they could only attend to light activities.

The findings in this chapter reveal that both men and women receive calorie reinforcement with respect to their health endowment. The disparity between genders may not be a serious problem in rural China. However, the disparity within gender class needs to be noted.

Roughly speaking, with the increase in labour force opportunities for women, resulting from development of rural industries and the family based land distribution system, women were allocated more food within the family. This has had a significant effect on the reduction of disparity between genders.

Our findings also suggest that increases in the health status of individuals, *ceteris paribus*, will increase the family's income, and this effect is greater for women. It appears that a woman's health is a key factor in determining whether her husband joins the industrial sector. Thus, women's health indirectly affects the development of rural industry. Just how does women's health affect the development of rural industry in China? We would need to undertake further research to answer this question.

Table 3.1: Descriptive Statistics

Variable	Definition	Obs	Mean	Std. Dev.
daycal91	Calorie intake in 1991	5667	2550	852
daycal89	Calorie intake in 1989	3175	2399	937
bmi91	Body mass index in 1991	6411	19.85	3.87
arm91	Arm circumference (cm)	6238	22.16	5.35
skin91	Skin fold (mm)	6002	9.29	5.47
female daycal91	Female calorie intake in 1991	2894	2404.49	738.88
female bmi91	Female body mass index in 1991	3226	20.11	4.03
male daycal91	Male calorie intake in 1991	2773	2702.36	933.25
male bmi91	Male body mass index in 1991	3185	19.58	3.67
hours91	Working hours outside household	6411	5.81	5.94
pcdef91	Per capita income in 1991	6411	1002.58	818.73
	Price variables			
pfish91	Fish	6411	3.95	1.60
pbean91	Beans	6411	0.47	0.26
price91	Rice	5104	0.65	0.28
pgric91	pgric91	6411	0.73	0.35
pflour91	Flour	6411	0.75	0.30
pegg91	Eggs	6411	2.12	1.47
pvege91	Vegetables	5653	0.33	0.33
ppork91	Pork	6411	3.53	2.61
pchic91	Chicken	6345	4.28	4.13
pbeef91	Beef	5475	4.62	4.03
light91	Light activity	6411	0.11	0.32
heavy91	Heavy activity	6411	0.46	0.50
vheavy91	Very heavy activity	6411	0.01	0.09
sex	sex	6411	0.50	0.50
age91yrs	Age in 1991	6411	28.40	19.26
agesq	Age squared	6411	1177	1355

Table 3.2: Individual Distribution of Activity by Sex in Rural China

	Males		Females	
Activity	Freq.	Percent	Freq.	Percent
1	153	5.74	116	4.22
2	172	6.46	276	10.03
3	898	33.71	803	29.19
4	1412	53	1538	55.91
5	29	1.09	18	0.65
Total	2664	100	2751	100

Sources: CHNS survey in 1991

Activity 1: very light physical activity (working in a sitting position, e.g., office worker watch repairer, etc.). Activity 2: light physical activity (working in a standing position, e.g. salesperson, teacher, etc.). Activity 3: Moderate physical activity (student, driver, electrician etc.). Activity 4: heavy physical activity (farmer, dancer, steel worker etc.). Activity 5: very heavy physical activity (loader, logger, miner, stonecutter, etc..)

Table 3.3: Individual Distribution of Calories and Body Mass Index (BMI) by Activity and Sex

		Females			Males		
Activity	Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
1	body91	116	21.5	3.9	153	22.2	3.5
	daycal91	114	2236.5	641.9	148	2607.0	671.8
2	body91	276	22.0	4.4	172	21.5	3.3
	daycal91	267	2410.2	567.3	166	2779.7	621.1
3	body91	803	18.4	3.9	898	18.1	3.8
	daycal91	564	2288.7	535.5	616	2590.0	794.1
4	body91	1538	21.4	3.0	1412	20.8	2.5
	daycal91	1522	2704.3	645.9	1396	3091.2	803.1
5	body91	18	22.0	2.6	29	21.9	3.1
	daycal91	18	2742.7	514.6	29	3241.0	836.1

Sources: CHNS survey in 1991

Activity 1: very light physical activity (working in a sitting position, e.g., office worker watch repairer, etc.). Activity 2: light physical activity (working in standing position, e.g. salesperson, teacher, technician, etc.). Activity 3: Moderate physical activity (student, driver, electrician etc.). Activity 4: heavy physical activity (farmer, dancer, steel worker etc.) Activity 5: very heavy physical activity (loader, logger, miner, stonecutter, etc..)

Table 3.4: Distribution of Calories by Age and Sex

	Females			Males		
Age	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
under 10	94	1778.6	528.2	107	1792.3	452.0
10--20	455	2451.5	545.1	469	2779.7	841.1
20-30	521	2727.5	678.3	477	3182.5	815.5
30-40	531	2661.0	573.1	460	3039.8	743.8
40-50	435	2679.2	616.1	404	3083.2	720.5
50-60	231	2558.0	636.9	226	2856.9	734.6
60-70	150	2304.6	563.2	144	2675.5	657.2
70-80	62	2010.0	601.3	57	2472.7	640.8
80-	6	1883.2	709.4	11	2069.7	524.4

Table 3.5.1: The 2SLS Estimate of Health Production (Dependent Variable is Body Mass Index)

Variables*	OLS		2SLS	
	Coef.	t	Coef.	t
Calorie consumption**	0.046	6.97	0.174	2.48
Middle heavy activity**	-0.031	-4.45	-0.090	-1.49
Heavy activity**	-0.017	-2.17	-0.174	-4.57
Very heavy activity**	-0.008	-0.36	-1.310	-2.90
Age	0.014	27.00	0.017	6.84
Age squared	0.000	-22.20	0.000	-5.89
Sex	-0.017	-2.29	-0.030	-2.65
Age * sex	0.000	-0.77	0.000	-0.12
Water from underground	-0.005	-1.04	0.014	1.67
Water from open well	-0.013	-2.16	0.008	0.76
Water from river, lake	-0.015	-1.89	0.009	0.77
Floor is concrete	0.030	2.14	0.016	0.80
Floor is brick	0.010	0.69	-0.002	-0.10
Floor is earth	-0.002	-0.14	-0.011	-0.59
Floor is wood	0.024	1.03	0.061	1.86
Very little excreta around the dwelling place	-0.014	-2.93	-0.004	-0.54
Some excreta around the dwelling place	-0.024	-4.74	-0.015	-1.87
Much excreta around the dwelling place	-0.012	-0.80	-0.008	-0.39
Constant	2.418	48.68	1.482	2.93
N	5586			5586
R sq	37.37			

* All variables are in logs except the dummy variables.
** These endogenous variables are instrumented by:
dummy for whether the household has professional cooking equipment, dummy for whether the household has poultry, household head's age and years of schooling, and food prices such as rice, flour and noodles, vegetables, eggs, pork, fish and beans.

Table 3.5.2: The 2SLS Estimate of Health Production by Sex (Dependent Variable is Body Mass)

Variables*	Male		Female	
	Coef.	t	Coef.	t
Calorie consumption**	0.276	4.24	0.204	1.35
Moderate heavy activity**	-0.113	-1.26	0.107	0.79
Heavy activity**	-0.204	-4.10	-0.154	-2.44
Very heavy activity**	-0.706	-1.59	-0.903	-1.31
Age	0.009	1.39	0.011	1.57
Age squared	0.000	-1.09	0.000	-1.08
Water from underground	0.007	0.67	0.033	2.05
Water from open well	0.003	0.21	0.022	1.38
Water from river, lake	0.004	0.32	0.018	0.91
Floor is concrete	0.005	0.19	0.031	1.12
Floor is brick	-0.010	-0.36	0.013	0.46
Floor is earth	-0.004	-0.16	-0.002	-0.08
Floor is wood	0.035	0.83	0.049	0.98
Very little excreta around the dwelling place	-0.014	-1.39	0.000	-0.03
Some excreta around the dwelling place	-0.017	-1.78	-0.006	-0.51
Much excreta around the dwelling place	0.007	0.31	-0.016	-0.53
Constant	0.769	1.66	1.192	1.07
N	2731		2855	
R sq				

* All variables are in logs except the dummy variables.

** These endogenous variables are instrumented by:
dummy for whether the household has professional cooking equipment, dummy for whether the household has poultry, household head's age and years of schooling, and food prices such as rice, flour and noodles, vegetables, eggs, pork, fish and beans.

Table 3.5.3: The 2SLS Estimate of Health Production (Log of Arm Circumference and Log of Triceps Skin)

Dependent variables	Log of arm circumference		Log of triceps skin	
Variables*	Coef.	t	Coef.	t
Calorie consumption**	0.103	2.06	0.821	4.79
Heavy activity**	-0.147	-4.69	-0.776	-8.34
Very heavy activity**	-0.152	-0.37	-3.065	-2.31
Age	0.027	12.32	0.018	2.42
Age squared	0.000	-11.36	0.000	-1.93
Sex	-0.007	-0.69	-0.350	-10.26
Age sex	0.001	2.35	-0.005	-5.31
Water from underground	0.015	1.82	0.052	1.92
Water from open well	0.013	1.38	0.028	0.85
Water from river, lake	0.014	1.21	0.094	2.25
Floor is concrete	0.081	4.14	0.145	2.15
Floor is brick	0.079	3.96	0.118	1.72
Floor is earth	0.063	3.32	0.102	1.56
Floor is wood	0.047	1.43	0.339	2.42
Very little excreta around the dwelling place	0.022	3.05	-0.022	-0.88
Some excreta around the dwelling place	0.008	1.04	-0.041	-1.53
Much excreta around the dwelling place	-0.029	-1.51	-0.007	-0.11
Constant	1.842	5.14	-4.064	-3.31
N	5342		5219	5219
R sq	43.45		41.25	.

* All variables are in logs except the dummy variables.

** These endogenous variables are instrumented by:

dummy for whether the household has professional cooking equipment, dummy for whether the household has poultry, household head's age and years of schooling, and prices of foods such as rice, flour and noodles, vegetables, eggs, pork, fish and beans.

Table 3.6.1: The Determinants of Calorie Consumption (2SLS)

	Total sample	
Variables *	Coef.	t
Own health endowment**	0.228	2.72
Family male health endowment **		
(not including himself)	0.012	0.13
Family female health endowment **		
(not including himself)	-0.183	-1.77
Per capita income**		
Household size	0.001	0.06
Age	0.043	2.96
Age squared	0.036	8.35
Sex	-0.001	-8.74
Age sex	0.114	2.15
Land	0.003	1.42
Proportion of family members male	-0.403	-1.58
Mean age of family members	0.004	1.68
Deviation of ages of family members	-0.008	-2.66
reg 1	-0.041	-1.73
reg2	0.101	4.61
reg3	0.018	0.62
reg4	0.187	3.97
reg5	0.097	4.38
constant	7.087	35.71
N***	1352	

* All variables in logs, except for dummies.
** Instruments are: household head's age and years of schooling, individual and family skin fold thickness and arm circumference measured in other year, the condition of floor, land holding and water sources.
*** This is the number of observations with information of health and nutrition for both 1989 and 1991. We need to use the health information in 1989 as instrumental variable.

Table 3.6.2: The Determinants of Calorie Consumption (2SLS)

	Male		Female	
Variables *	Coef.	t	Coef.	t
Own health endowment**	0.207	1.87	0.394	3.02
Family male health endowment** (not including himself)	-0.116	-1.05	0.000	0.00
Family female health endowment ** (not including himself)	-0.173	-0.95	0.026	0.17
Per capita income**	0.005	0.18	-0.030	-0.91
Household size	0.033	2.55	0.015	1.21
Age	0.041	7.43	0.033	3.64
Age squared	-0.001	-7.96	0.000	-3.74
Sex				
Age sex				
Proportion of family members male	-0.766	-0.91	0.066	0.58
Mean age of family members	0.007	2.25	0.000	-0.05
Deviation of ages of family members	-0.008	-2.31	-0.009	-2.20
reg 1	-0.014	-0.40	-0.076	-2.34
reg2	0.106	3.37	0.076	2.80
reg3	0.017	0.35	-0.019	-0.51
reg4	0.255	3.91	0.129	1.89
reg5	0.106	3.52	0.113	3.32
constant	7.553	15.33	6.81	24.11
N	670		682	

* All variables in logs, except for dummies.

** Instruments are: household head's age and years of schooling, individual and family endowment of skin fold thickness and arm circumference measured in other year, the condition of floor, land holding and water sources.

Table 3.7.1: The Determinants of Activity Choice (Two Stage Probit Model): Dependent Variable is the Dummy for Heavy and Very Heavy Activity

	Coef.	z	Marginal effect
Own health endowment*	4.332	8.13	1.439
Sex	-0.032	-0.68	-0.011
household size	0.225	8.19	0.075
Age	-0.003	-7.65	-0.001
Age sq	-0.103	-0.26	-0.034
Age*sex	0.003	0.24	0.001
Land	0.114	5.77	0.038
reg1	-1.153	-7.29	-0.425
reg2	-1.158	-8.46	-0.423
reg3	-1.827	-10.52	-0.634
reg4	0.257	0.18	0.078
reg5	-0.347	-1.79	-0.123
Proportion of family members male	0.117	0.41	0.039
Mean age of family members	-0.010	-1.48	-0.003
Deviation of ages of family members	-0.010	-0.90	-0.003
Constant	-9.786	-10.31	
N	1619		

* Instrumental variables are household head age and years of schooling, individual health endowments for arm circumference and skin fold thickness measured in 1989.

Table 3.7.2: Determinants of Per Capita Family Income by Sex

Variables	Female		Male	
	Coef.	t	Coef.	t
Own health endowment*	1.373	4.59	0.612	2.41
Household size	-0.101	-3.42	-0.023	-0.69
Age	0.001	0.01	-0.105	-2.13
Age squared	0.000	-0.06	0.001	1.97
Land	0.001	0.13	-0.005	-0.48
reg1	-0.012	-0.12	-0.035	-0.31
reg2	0.185	2.14	0.190	1.99
reg3	0.126	1.08	0.202	1.46
reg4	0.237	0.96	-0.053	-0.11
reg5	0.230	2.13	0.203	1.68
Proportion of family members male	-0.058	-0.33	-0.038	-0.17
Mean age of family members	0.021	4.16	0.024	4.51
Deviation of ages of family members	-0.020	-2.61	-0.029	-3.39
Constant	4.177	4.55	7.190	7.21
N	725		615	
R sq	0.084		0.088	

* Instrumental variables include individual health endowments for arm circumference and skin fold thickness measured in 1989.

Table 3.7.3: The Effect of Health Endowment on Wage by Sex

Variables	Female		Male	
	Coef.	t	Coef.	t
Own health endowment*	1.049	3.25	0.612	2.41
Household size	-0.036	-1.39	-0.023	-0.69
Age	-0.004	-0.09	-0.105	-2.13
Age squared	0.000	-0.13	0.001	1.97
Land	-0.014	-1.49	-0.005	-0.48
reg1	0.233	2.36	-0.035	-0.31
reg2	0.275	3.20	0.190	1.99
reg3	0.467	4.39	0.202	1.46
reg4	0.108	0.55	-0.053	-0.11
reg5	0.326	3.37	0.203	1.68
Proportion of family members male	-0.244	-1.47	-0.038	-0.17
Mean age of family members	0.024	4.86	0.024	4.51
Deviation of ages of family members	-0.030	-4.06	-0.029	-3.39
Constant	-3.078	-3.36	7.190	7.21
N	936		784	
R sq	0.088		0.074	

* Instrumental variables include individual health endowments for arm circumference and skin fold thickness measured in 1989.

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Chapter 4

It's True about Mothers-in-Law: Discrimination and Bargaining Power within Families

4.1 Introduction

Chapter 3 examines the relationship between calorie consumption and individual health endowment taking into account the linkage between health status and labour market productivity in the framework of the common preference model. We find that the individual health endowment affects calorie consumption distribution. This finding, however, also is consistent with the bargaining model. This chapter emphasises the distinction between the common preference model and the bargaining model.

Welfare, living standards, and poverty are all characteristics of individuals of households, but there is not a one to one mapping from the individual to the household. Some members of a household may be poorer than others. Therefore, it is important to understand how resources are allocated within the household. Over the past two decades, a large body of literature has developed which documents that, in some areas of the world, the allocation of household resources favours males over females (Dreze and Sen 1989; Harriss 1990; Strauss and Thomas 1998). This may well be true of China. One of the best known findings in this literature relates to the extent of excess infant mortality among girls, particularly in China (Dreze and Sen 1989; Coale 1991). Another relevant fact about China is that the life expectancy gap between males and females is much smaller than the world average. The life expectancy of females in China is only three years greater than males, while the world average gap is about eight years. In this chapter, we add to this literature by asking whether a gender bias exists between husband and wife in the allocation of resources within the family, particularly in poor rural areas. The question we address is: "Are wives treated equally within the family?"

To answer this question we focus our attention on comparing the health status and nutrient intake of husbands and wives. We measure health status using Body Mass Index (BMI) which is a ratio of height and weight squared. The BMI is thought to be a good measure of health status of human beings because it is closely related to the mortality rate and many illnesses. Nutrient intake is measured by calorie and protein consumption. In a poor economy, nutrient intake directly determines the individual's health status and labour productivity and thus it is closely related to an individual's welfare.

The common preference model (Samuelson 1956, Becker 1981) assumes that the respective weighting of each family members in the household's utility is independent of environmental factors (wages, prices, individual incomes and other social or economic characteristics). For example, those who can earn a low wage, say the wife, receives the same weighting as the member who can earn a high wage, say the husband. The common preference model assumes that all members of the family jointly maximise a common objective function because selfish members find it in their self-interest to subscribe to the altruist's objective. The strong implication of this model is that the demand for each commodity is invariant to the division of resources within the family. In addition, the social-economic characteristics of the individual do not affect demand if they do not affect family preferences.

The bargaining model assumes that the household can be thought of as a group of individuals who bargain with each other over resources (Manser and Brown 1980; McElroy and Horney 1981; Lundberg and Pollak 1993). For example, the allocation of nutrients between a husband and wife may depend on the threat point, which is interpreted as the utility of remaining single or of getting divorced (outside option) (McElroy and Horney 1981), or as the non-cooperative equilibrium within marriage (inside option) (Lundberger and Pollak 1993). Chiappori (1988,1992) assumes that resource allocation within the household is Pareto efficient. Under this assumption, we can recover the preferences from the allocation outcomes without knowing the decision making process. The empirical work by Browning, Bourguignon, Chiappori and Lechene (1994) suggests that the consumption of husband and wife is related to their individual resources. That is the bargaining model has a better prediction of outcomes than the common preference model. We have called the factors affecting the sharing rule *distribution factors.* In this chapter, the location of the husband's mother-in-law is one kind of distribution factor.

We will test whether the ratio of nutrient intake and the health status of the husband and wife are affected by social-economic characteristics such as the location of mothers-in law (i.e. wives' parents), which is unlikely to affect individual preferences. Our test can help us to determine whether the common preference model is consistent with the data. If the common preference model is correct, we will find that the ratio of nutrient intake between husband and wife should not depend on individual characteristics that do not change the preference, such as whether the wife's mother lives close or far away.

Under the framework of the bargaining model, however, it matters where the wife's mother lives. If the wife's family lives close by, this might increase the wife's utility from divorce because she can easily get help from her parents. This help includes financial and emotional support. Considering the very low divorce rate in China before the 1990s, the separate sphere bargaining model may be a better alternative to describe bargaining leverage between husband and wife. This model assumes that divorce is not allowed and that the threat point is a non-cooperative Nash equilibrium. In this case, the wife can readily obtain help from nearby parents. For example, the wife's parents can easily lend their daughter physical and monetary support such as taking care of the children, sharing some homework and intervening with their son-in-law if their daughter is badly treated. This intervention can shift the power balance in the family and increase the wife's nutrient intake. The prediction using the bargaining model is that the wife's share of allocated resources should be relatively higher if her parents live nearby, than if her parents live further away (for instance in a different county).

Most of the existing literature studying gender bias in resource allocation within the household, is concerned with the direct comparison (by gender) of nutrition, health or education (Deaton 1997). Although there is considerable evidence of gender bias, the mechanisms underlying gender bias are not fully understood. In this chapter, we will attempt to establish the association between a series of outcomes of household resource allocation and a particular social-economic factor (i.e. location of mothers-in-law) that may affect the threat point of wives but not their preferences.

Previous research has usually focused on gender bias against women as a group. In this chapter we focus on the relative sharing of allocated resources between husbands and wives who are decision makers within families. This can shed light on the mechanism of gender bias within the family structure.

In Chinese society, particularly in rural areas, males are the dominant partners in households because they are the primary income earners. In addition, tradition and cultural factors favour men against women. We guess that although the relative bargaining power between husband and wife will affect the resource allocation within the family, the prediction of the male is so strong that the location of husband's mother will have no significant effect on resource allocation between husband and wife. Men usually hold enough bargaining power over resources within the family that they may not need help from their parents. In contrast, women are usually weak negotiators in the bargaining process and may need help from outside the family. Therefore, the status of wife's mother may significantly affect resource distribution between husband and wife. In this chapter, we refer to the mothers-in-law as the wife's parents.

This chapter is organised as follows: section 4.2 discusses the background; section 4.3 presents the theoretical model; section 4.4 presents the econometric specification; data and empirical results are discussed in section 4.5; section 4.6 examines the robustness of our results; section 4.7 is the conclusion.

4.2 Background

This chapter will study the relative nutrient status of husband and wife. Three measures of nutrient status are considered: calorie intake, protein intake and body mass index (Quetelet index). The body mass index is now recognised as a reliable measure of the nutritional status of adults (Deaton 1997; Dercon and Krishnan 2000). It is defined as weight in kilograms divided by squared height in meters. The body mass index can be used to measure chronic energy deficiency in adults. Some findings suggest that low values of body mass index (below 18) are associated with higher adult mortality (Waaler 1984). In addition, the body mass index is also recognised as a measure of the amount of energy stored in the body.

We use data from the Chinese Health and Nutrition Survey (CHNS). There are about 1,274 couples from rural China in the survey who provided socio-economic information of interest. This chapter focuses on these 1,274 couples.

Table 1 presents the mean levels of body mass index, calorie intake and protein intake in rural China. The mean of the body mass index is just below 22 for both males and females, which is the same as the usual national average in poor countries (i.e. between 21 and 23). Vosti and Witcover (see Dercon and Krishnan 2000) report means of body mass index for a particular area in south central Ethiopia that are 18.4 for males and 19.1 for females. Gillespie and McNeill (1992) report a mean for a village in south India of 19.1, for both men and women. In the United Kingdom, the mean value is 24 and, in the United States, the mean value is approximately 25.

Table 4.1: Nutrient Status between Husband and Wife

	Ratio of husband to wife	Husband	Wife
Calorie intake	1.06	2775.8 (1068)	2616.0 (718)
Protein intake	1.06	80.4 (34.5)	75.5 (25.3)
BMI	0.99	21.8 (2.8)	21.9 (3.0)

Note: the standard errors shown in parenthesises.

In our data, the ratios of calorie intake and protein intake between husband and wife are both 1.06. In determining if this ratio only reflects the difference of biological need between a husband and wife, we ask if factors affecting the bargaining power of husband and wife (such as if the mother-in-law lived nearby), have any influence on theses ratios.

4.3 The Models

4.3.1 Common preference model

Chapter 3 emphasises the links between health status and labour market productivity. In this chapter, we try to test the common preference model against the bargaining model. We discuss again the common preference model as follows. The household is assumed to maximise a social welfare function:

$$U = U(u_1(X, N(X), Z_1), u_2(X, N(X), Z_2) \ldots u_H(X, N(X), Z_H)). \qquad (4\text{-}1)$$

subject to:

$$pX = \sum_{h} w_h T + W_h, \tag{4-2}$$

The family's social welfare depends on individual utility. X is a vector of commodities such as food, N represents nutritional status such as the body mass index, calorie intake or protein intake. The household consists of H members. Z_h is a vector of individual characteristics such as age, education and so forth that are thought to affect preferences. p is the price vector, w_h is the wage rate for household member h, W_h is unearned income.

The household demand function depends on all prices, wage rates and unearned income. The demand for commodity X and nutrition N are as follows:

$$N = f(Z, p, w, \sum W_h) \qquad X = g(Z, p, w, \sum W_h) \tag{4-3}$$

demand depends on individual characteristics, price and total income. The household acts as if it pools all unearned income.

To make the analysis a little clearer, we write the family welfare function as follows:

$$U = \sum_{h=1}^{H} \theta_h u_j (X, N(X), Z) \tag{4-4}$$

and assume the price of N is P_N[15]. Consider the optimal allocation of N between two individuals i and j of the same household. If we maximise (4) subject to the constraint, we derive the first order condition as:

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[15] If the N is body mass index it must be durable. P_N represents user cost (Deaton and Muellbauer 1980).

$$\frac{\partial u_i / \partial N_i}{\partial u_j / \partial N_j} = \frac{\theta_j}{\theta_i} \cdot \frac{P_{N_i}}{P_{N_j}} \tag{4-5}$$

To illustrate this condition, let us assume that the utility function is the form: $N^{1-\rho}/(1-\rho)$,[16] and the price of N is equal between i and j, (4-5) can be written as:

$$\log(\frac{N_i}{N_j}) = \frac{1}{\rho} \cdot \log(\frac{\theta_i}{\theta_j}) \tag{4-6}$$

The log ratio of nutrient status between husband and wife is set equal to the proportion of the log ratio of the weighting that is given to each individual in the household by the family planner. According to Samuelson (1956), this weighting should not depend on environmental variables such as price, income and other social characteristics (eg. the location of the wife's mother).

The common preference model shows that the demand ratio between household members should not be affected by the location of the mother-in-law, as long as her location does not affect the preferences of households. Furthermore, if we assume that the location of the wife's mother does not affect the total income of the household, the level of demand will be unrelated to the location of the mother-in-law. The latter assumption seems a little

[16] Utility may also depend on individual characteristics such as age, gender and physical characteristics. For simplicity, we omit them in our utility function since we want to emphasise that the allocation rule is closely related to weighting index that is associated with each family member in household utility. In the regressions below, we control for these individual characteristics. For example, the height and weight has been controlled for when we estimate calorie consumption.

strict because a woman's mother is likely to give more support to her daughter's home, for instance, give more gifts or share some home work, and this would change the total amount of resources available for the household. In this case, both the husband's and wife's demand level will increase (or decrease) when the mother-in-law lives nearby (further away) because the total resources may increase (or decrease). When resource allocation between husband and wife is determined by a bargaining procedure, the supplementation from wife's parents may increase wife's nutrient intake relatively more compared with the husband. If the common preference model correctly described the resource allocation within the family, we should observe that the demand ratio between husband and wife should not be related to the location of the mother-in-law.

However, if we consider the effect of the location of mothers-in-law in an alterative framework such as the bargaining model, we will have a very different prediction.

4.3.2 Bargaining model

Bargaining models treat the household as a group of individuals who bargain with each other over resources. Manser and Brown (1980) discuss both Nash and Kalay-Smorrodingsky's definitions of a bargaining equilibrium; McElroy and Horney (McElroy and Horney 1981; McElroy 1990) focus on Nash equilibrium. Lundberg and Pollak (1993) consider separate sphere bargaining in that the threat point is not divorce but a non-cooperative equilibrium within marriage. This non-cooperative equilibrium reflects traditional gender roles. For example, men carry the responsibility for earning income and women carry responsibility for activities within the household.

Consider a husband's and wife's bargain over the quantities of four variables, namely, the consumption levels of two private goods (N_H and N_W) and two household public goods (X_1 and X_2). The income of the husband and wife are denoted as Y_H and Y_W , The sum of the husband's and wife's incomes is greater than zero. The price of the private good is normalized to one, and the prices of the public good are P_1 and P_2 .

The husband and wife will choose private and public goods to maximise the product of the differences between the utility level each achieves from the goods and the threat point of the reservation utility level.

$$MAX(U_H(N_H, X_1, X_2) - V_H)(U_W(N_W, X_1, X_2) - V_W) \qquad (4\text{-}7)$$

s.t. $N_H + N_W + p_1 q_1 + p_2 q_2 = Y_H + Y_W$

Manser and Brown (1980) and McElroy and Horny (1981) assumed that while bargaining, each player has the option to divorce--which entails permanent disagreement. Thus the utility pair associated with divorce is the outside option point. In the above problem, if V_H and V_W are the outside option, they will depend on factors such as income and other environmental parameters (divorce laws, taxes, welfare payments and sex ratios). Location of the wife's mother may affect the outside option. For example, a mother who lived nearby can provide accommodation for a divorced daughter. It would be convenient for a wife to live in her parent's home before she begins the next marriage or a new life after she is divorced. Thus the location of the mother-in-law matters.

However, in China, the very low divorce rate, particularly in rural areas (before the 1990s), suggests that the alternative bargaining model, in which the threat point is determined by the inside option may be a better description of the bargaining process within the household. If the wife temporarily disagrees over the allocation, the household continues to function and the couple lives together, but in the absence of co-operation. Based on established gender roles, to which the parties are committed, the husband controls and chooses private good N_H and public good X_1 and the wife controls and chooses private good N_W and public good X_2. The player's inside options are in line with the Nash equilibrium payoffs of the following simultaneous move game. The husband chooses N_H and X_1 s.t. $N_H + p_1 X_1 = Y_H$, and simultaneously, his wife chooses N_W and X_2 s.t. $N_W + p_2 X_2 = Y_W$. The payoffs from these strategy choices, to the husband and the wife are: $G_H(N_H, X_1, X_2)$ and $G_W(N_W, X_1, X_2)$ respectively. We assume that the Nash equilibrium payoffs in this game are uniquely defined, and that they define the inside option point $V_H(Y_H, Z)$ and $V_W(Y_W, Z)$, where Z is a vector of factors that affect the husband's or the wife's utility level in the non-cooperative game (eg. the location of the mother-in-law).

The demand for private goods is

$$N_i = f(p, Y_H, Y_W, Z) \text{ where } i = H, W \qquad (4\text{-}8)$$

and the ratio of demand between husband and wife is:

$$Log\left(\frac{N_H}{N_W}\right) = g(p, Y_H, Y_W, Z). \qquad (4\text{-}9)$$

There are three channels through which the location of the mother-in-law might affect the demands of husbands and wives for private goods and the demand ratio between them: the wealth effect, the insurance effect and the intimidation effect (nagging or complaint).

Firstly, by increasing the income of the wife, the mother-in-law raises the wife's bargaining power. This increases the wife's inside option which is a function of Y_W. While the husband's inside option does not change, the wife's demand increases relative to the husband's.

When the mother-in-law's home is nearby, the wife can gain benefit from her mother's home in several ways. The mother-in-law can help to look after the children, at least when necessary. In rural areas, the labour of the mother-in-law's home can be utilised during peak seasons (harvest or planting times). The wife can also return to her mother's home for short periods of time. All of these activities will increase the wife's resource availability or reduce her living expenses.

Secondly, the potential benefit that the wife can gain from a mother who lives nearby is "ready help". People in developing countries, such as China, face many risks including volatile income and expenditure shocks. If the wife's mother lives close, they can easily co-insure each other. The "ready help" effect demonstrates that the wife's bargaining position will be enhanced when her mother lives nearby.

Thirdly, there is an intimidation effect. When the mother-in-law lives nearby, she can easily observe the bargaining outcomes between husband and wife. If the wife's share is too low, the mother may start to complain to help her daughter get more. In extreme cases, the wife's brothers (they would also usually live nearby) might intimidate the husband into treating his wife equally.

When the mother-in-law lives nearby, these three influences will increase the wife's share of consumption relative to her husband. Furthermore, while the wife's consumption level might increase when the mother-in-law lives nearby, the husband's consumption level may decrease or keep constant. We will test this hypothesises in the next section[17].

4.4 Econometric Specification

Our empirical section focuses on the relationship between measures of the health status of the husband relative to that of his wife and the location of his mother-in-law. The measures we use are protein intake, the calorie intake ratio and the BMI ratio. A small number of studies have used individual nutrient intake data to study intra-household inequality in nutrient intake (Behrman 1988; Behrman and Deolalikar 1989; Pitt, Rosenzweig et al. 1990; Thomas 1990).

Recall equation (3-5), we rewrite it as:

$$\frac{\partial u_i / \partial N_i}{\partial u_j / \partial N_j} = \frac{\theta_j}{\theta_i} \cdot \frac{P_{N_i}}{P_{N_j}}$$

from this first order condition, we derived equation (4-6) under the restriction that prices facing household members are equal. This is reasonable for calorie and protein intake because the household usually prepares food together unless the husband and wife eat different food.

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[17] The location of mothers-in-law could be endogenous because the parents can choose where their daughter marries when making the marriage decision. We need an explicit model to

The user cost (for BMI) between members is assumed to be the same[18]. User cost is primarily determined by the marginal return from increasing nutrition and this may be very similar at not so low levels of nutrition. In fact, the average BMI is about 22 in China, while the average of this index for poor countries is between 21-23. It is safe to assume that user cost is the same between members because we also examine the demand for calorie intake and protein intake, the price of which is the same between members. If we can obtain similar results for both BMI and nutrient intake, neglecting the difference in user cost between members may not result in a serious problem. In addition, even though there exists a difference in user cost, it can be controlled for in our regression, to some extent, by variables such as education and activity level.

We will estimate the following specification:

$$\log\left(\frac{N_H}{N_W}\right)_i = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3\, x_3 + \gamma \text{ control variables} \tag{4-10}$$

where the dependent variables are the calorie intake ratio, the protein intake ratio or the body mass index ratio of the husband relative to that of his wife, x_1 is the dummy variable for the husband who lives in his mother-in-law's home or as a neighbour, x_2 is the dummy variable for when the mother-in-law lives in the same village (but not as a

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describe the decision of the location of the wife's parents. Here, for simplicity, we assume that the location of mothers-in-law is exogenous.

[18] This is the assumption to derive 3-5. In fact, in the regression of BMI ratio between husband and wife, education and activity level have been controlled. These variables may control different user costs facing husband and wife.

neighbour), x_3 is the dummy variable for when the mother-in-law lives in a different village but in the same county, x_4 is the dummy for when the mother-in-law lives outside the same county. The excluded variable is x_3. The control variables include: dummy variables for the activity level of both husband and wife, dummy variables for the level of education of both the husband and wife, regional dummy variables, and the age of husband and wife. For the regression of calorie intake and protein intake, we also control for the relative heights of husband and wife.

From the analysis in section 3, the income effect, the "ready help effect" and the intimidation effect imply that coefficients of x_1, x_2 and x_3 are negative. Activity levels directly affect the body mass index and how much nutrition (calories and protein) is required to sustain activity. To control for this biological need effect, we use 5 dummy variables to represent the activity levels: very light physical activity (working in sitting position e.g office worker, watch repairer); light physical activity (working in standing position such as sales person, teacher); moderate physical activity (student, driver, electrician, metal worker); heavy physical activity (farmer, dancer, steel worker, athlete); very heavy physical activity (loader, logger, miner, stonecutter). We did not use occupational dummies because of the high correlation with activity levels. For the regression of calorie and protein intake, we also control for the height of both husband and wife. It is reasonable to assume that the taller person will demand more nutrients. Weight also affects nutrient intake. However, weight is different from height since height can be thought of as constant for adults. Height is exogenous in our regression, but weight is different. On one hand, the greater the weight, the greater the demand for nutrients. On the other hand, the greater the intake of nutrients, the greater the weight.

We ran regressions with and without controlling for weight. We found that whether we treated weight as exogenous or endogenous had no significant influence on the coefficients of the dummies for location of mothers-in-law.

The nutrient ratio between husband and wife also depends on education level. Firstly, education level is related to bargaining power. The higher the education level of the wife, the more likely it is that the wife will be treated equally. Secondly, education level can also represent differences in preferences.

Regional dummy variables included in the regression are used to control for differences in preferences and for some unobserved environmental factors. Our data came from eight provinces which range from north to south, and from the plains to the mountain areas. Consider two couples, one lives in north China where it is very cold, the other lives in the warm south. We assume that the wives usually stay inside the house to do homework but the husband must work outside. Under different climactic conditions, the ratio of nutrient intake between husband and wife may be higher in the north than in the south.

Age variables are used to control for the length of marriage history. It maybe that the older the wife, the more likely she will be treated equally.

Recall that the analysis in section 4.3 predicts that the nutrient demand for husband and wife will change in the same direction with the location of the mother-in-law if the common preference model is correct. If the mother-in-law lives nearby, the household can receive more benefit from the financial and physical support given by the mother-in-law than if she lives outside the same county. Hence, if the household budget has been increased, both the husband's and his wife's demands will increase because the altruism model implies income pooling. However, the bargaining model predicts that the demands of the husband and wife may change in different directions with the location of the mother-in-law.

Accordingly, we also estimate the demand for nutrients of the husband and wife separately. The specification is as follows

$$\log(N_i) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_4 + \gamma \text{ control variables} \quad i = H, W \tag{4-11}$$

The control variables include individual height, weight, activity, education, regional dummy variable and age. The common preference (altruism) model predicts that the coefficient of the dummy variable for the location of the mother-in-law should have the same sign and the same size for the husband and wife. The bargaining model predicts that these coefficients should have the opposite sign.

The location of the mother-in-law may be endogenous. For instance, the woman with higher bargaining ability is more likely to marry further away because she believes that ready help from her mother is not necessary. This means that the dummy for the mother-in-law who lives in a different county may be negatively related with the error item, hence our coefficient would be underestimated.

We have tried to instrument the location of the mother-in-law [19]. The excluded instrumental variable is the dummy variable for village. Firstly, the village dummy has some relation with the marriage decision. For instance, women in a village consisting of the same surname households find it difficult to marry within the village because the culture discriminates against couples with the same surname. Secondly, the village dummy may have no correlation with the degree of discrimination. Therefore, the village dummy could be a good instrumental variable to exclude.

4.5 Data and Results

The data used in this study is from the 1991 China Nutrient and Health Survey (CHNS). Table 4.2 presents the description of the data and the definitions of the variables used. The dependent variables in our regressions include the ratios of BMI, calorie and protein intake between husband and wife. To estimate the impact of the location of mother-in-law unbiasedly, we need to solve the problem of heterogeneity. What we can do in this chapter is to control for as many variables as possible. We try to control for the husband's and wife's physical activity levels, years of schooling, years of schooling squared, age, age squared and region dummy variables. These controlling variables may reflect the

[19] The results using instrumental variables are not reported because the results are similar. Estimation using instrumental variables increases the estimated coefficient from 5% to 9-10%, but estimate is not statistically significant.

heterogeneity of individual preferences and the needs effect. As more variables are controlled for, the possibility of omitting variable bias decreases.

Table 4.3 reports two versions of the regressions of the body mass index ratios between husband and wife against location of the mother-in-law. The results suggest that the location of the mother-in-law affects the BMI ratio. Regression 1 includes one dummy variable for households where the mother-in-law lives outside the same county. This coefficient implies that the BMI ratio, in households where the mother-in-law lives outside the same county is, on average, 9.5% lower than the ratio of households where the mother-in-law lives within the same county.

We also present regression 2 which includes three dummy variables for the location of the mother-in-law: (1) living together or as a neighbour; (2) living in the same village but is not a neighbour; (3) living in a different village in the same county. We have omitted the group of households where the mother-in-law lives outside the same county. The coefficients of the three dummies are significant and have negative signs, as predicted by the bargaining theory. The coefficients show that the BMI ratio in these three groups of households are, on average, 8-10% below that of households where the mother-in-law lives outside the same county.

Although we have controlled for variables as much as we can, the regression results suggest that only a small part of the variation of BMI ratios between husband and wife have been explained. There are two possible reasons for the low value of R squared (about 5%) in our results. One is a measurement error problem. That is, much of the variations of the BMI ratios reflects measurement errors rather than true resource distribution between husband and wife. The other is that we failed to include key variables that affect the resource distribution between husband and wife. Without further information, we may not be able to solve these two problems.

To ensure that the potential bias from the different user cost of family members will not affect our estimate of the effect of the location of mother-in-law, we also estimate the ratios of calorie and protein intake that are believed to have the same prices between family members[20]. The results are reported in Table 4.4. We have omitted the group of households where the wife's parents live outside the same county. The coefficients of the dummy variable where the mother-in-law lives as a neighbour, are significant at 10% level and have a negative sign in both regressions of calorie and protein intake. The ratio of calorie and protein intake of the husband relative to the wife, for the household where the mother-in-law lives as a neighbour are, on average, 4.7% and 5% below a comparable household's ratio.

It is worthy of noting that in both the regression of calorie and protein intake, the age of the wife has an effect on the nutrient ratio for the couple. If the wife is older, the ratios of nutrient intakes are higher. Perhaps the power of older generation women is lower because of culture or tradition.

Again, we have only explained a small part of the variation in the ratio of nutrient intakes. The R squared is 10% now, a little higher than that in the regression of the ratio of BMI.

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[20] Actually, if there are links between individual health status and labour market productivity, the shadow prices facing individual family members may still differs.

Because we have used the log ratio of nutrient intake between husband and wife as independent variables in Table 4.3 and 4.4, family fixed effect has already been controlled for. To understand how fixed family effect drive our results we report the estimation of the wife's and husband's demand for calorie and protein in Table 4.5 and 4.6.

In these regressions, the group of households where the mother-in-law lives in a different village but in the same county is omitted. The demand for calories and protein by wives whose mothers live outside the same county is 3.7% and 5.5% lower than the omitted group. The coefficients attached to the other dummy variables related to the location of the mother-in-law are not significant. It is worth noting that the coefficient for the wives whose mothers lived together or as neighbour has a wrong sign. We guess this may come from the failure to control for the family fixed effect.

In the regression of the husband's demand for nutrients, the result is quite the opposite. The dummy where the mother-in-law and family share the same house or where they live as neighbours is significantly negative and this has a sizeable effect on the husband's demands. Where the mother-in-law lives outside the same county, the demands of the wife are significantly affected but the same situation has little effect on the husband's demands.

The location of the mother-in-law affects the demands of husbands and wives differently. However the signs of the dummies of the location of the mother-in-law demonstrate that a complicated decision process lies behind these regressions.

4.6 The Robustness

4.6.1 Home location of the husband's mother

The location of the wife's mother matters in the context of the allocation of household resources, but how does the location of the husband's mother affect this arrangement? In Chinese society, particularly in rural areas, males are the dominant partners in households because they are the primary income earners. In addition, tradition and cultural factors favour men against women. We predict that the husband's mother has no effect on resource allocation between husband and wife. This conjecture is examined and results are reported in Tables 4.7 and 4.8. The location of the husband's mother has no effect on the ratios of BMI, calorie and protein intake between husband and wife.

4.6.2 Distance

In our discussion, the distance that the wife's mother lives from her daughter's household affects the mother's influence over her daughter's situation. We assume therefore that the income effect, "ready help" effect and intimidation effect deteriorate with increased distance. In the above regressions, the way of constructing dummies for the location of the mother-in-law may not correctly reflect the true distance. For example, if two households from different counties live on the border of two adjoining counties, the construct of the location dummies may be misleading.

Dummy variables are reconstructed by using the physical distance of the mother-in-law's home from the household's home. Households were then divided into three groups. The first group represented households where mothers-in-law lived within 0.5 kilometres (xx1), the second group represented mothers-in-law located between 0.5 to 20 kilometres from their daughters' homes (xx2), the third group for those living more than 20 kilometres away (xx3).

The results are reported in Table 4.9 and 4.10. The effect of the location of the mother-in-law measured by distance (kilometres) has no significant effect on the BMI ratio. However, the location of the mother-in-law has a significant effect on ratios of calorie and protein intakes. Roughly speaking, for the wives whose mothers lived over 20 kilometres away (xx3), the ratio of calorie and protein intake between husband and wife averagely are 3% and 3.3% greater than for those wives whose mothers lived less than 20 kilometres away.

In the second instance, dummy variables are constructed using time spent on the trip to the mother-in-law's home. The results are reported in Table 4.11 and 4.12. Households were again divided into three groups. The first group represented households where mothers-in-law's lived together or as a neighbours (tt1), the second group represented mothers-in-law who were located between 0 to 150 minute trip from their daughters' homes (tt2), the third group was for those living more than 150 minutes trip away (tt3). The results indicate that the location of the mother-in-law (tt1 and tt3) significantly affects the distribution of consumption between husband and wife.

In conclusion, the results suggest that the wife's welfare is significantly affected by these two measures, i.e. distance and trip time to the location of the mother-in-law. This may suggest that the location of mother-in-law really matters in the allocation of resources between husband and wife within the family.

4.7 Conclusion

In this chapter, we tested the effect of the location of mothers-in-law relative to resource allocation within the family. We find that the ratios of the Body Mass Index, calorie and protein intakes between husband and wife are affected by the location of the wife's mother. This implies that the bargaining model which capture the bargaining power of each family member, might be a more realistic model than the common preference model to describe resource allocation within the family.

The implications of the findings in this chapter are important for policy analysts. For example, studies on inequality that fail to notice the potential for inequality within the family might be very misleading. If the bargaining power of family members directly determines their share of consumption in the family, policy makers may be able to protect vulnerable people such as poorly educated women and their children for a very low cost. For example, if governments change the target of some support programs from the husband of the household to the wife, this would alter the distribution patterns of consumption within the family. This change would favour women without increasing government expenditure. If the government in China can do this, the benefits from improving the status of women may well be large. For instance, mothers would increase their bargaining power and this is known to be associated with better education for children.

One residual problem in our empirical test in this chapter is that we did not model the marriage decision and could not use this information to solve the self-selection problem as it relates to where the couple lives in relation to the wife's parents. For example, if the well educated woman (hence, more bargaining power) intends to marry a man from a long distance, our result will understate the effect of mothers-in-law. In the context of Chinese rural areas, a man may intend to marry a woman who is from a remote poor area (hence, less bargaining power). This will make us overstate the effect of mothers-in-law. Lacking information about the marriage decision, we could not judge the direction of bias. So we need to be a little cautious in interpreting our results.

Table 4.2: Description of the Main Variables

Variable	Definition	Obs	Mean	Std. Dev.
hcal91	Husband calorie intake in 1991	1274	2775.8	1068.2
hpro91	Husband protein intake in 1991	1274	80.4	34.5
wcal91	Wife calorie intake in 1991	1274	2616.0	718.7
wpro91	Wife protein intake in 1991	1274	75.5	25.31
hweight	Husband weight	1104	60.9	12.22
hheight	Husband height	1104	165.8	9.41
wweight	Wife weight	1203	53.4	8.31
wheight	Wife height	1203	155.9	7.10
hbody	Husband BMI	1099	21.8	2.81
wbody	Wife BMI	1053	21.9	3.02
hage	Husband age	1274	35.0	7.1
hages	Husband's wage squared	1274	1360.0	554.02
wage	Wife age	1274	34.4	7.00
wages	Wife's age squared	1274	1237.0	584.01
size	Household size in 1991	1274	4.51	1.58
	Husband activity dummy variables			
ha1	Very light physical activity	1274	0.10	0.30
ha2	Light physical activity	1274	0.09	0.29
ha3	Heavy physical activity	1274	0.57	0.50
ha4	Very heavy physical activity	1274	0.02	0.14
	Wife activity dummy variables			
wa1	Very light physical activity	1274	0.07	0.26
wa2	Light physical activity	1274	0.16	0.36
wa3	Heavy physical activity	1274	0.63	0.48
wa4	Very heavy physical activity	1274	0.01	0.08
hsch	Husband's years of schooling	1274	7.98	3.31
wsch	Wife's years of schooling	1274	6.09	4.02
	Dummy variables for the location of husband's mother-in-law			
x1	in the same family or as neighbour	1274	0.07	0.26
x2	in the same village	1274	0.18	0.38
x3	in the same county	1274	0.62	0.48
x4	in the different county	1274	0.13	0.34
	Dummy variables of location husband's parents			
y1	in the same family or as neighbour	1274	0.40	0.49
y2	in the same village	1274	0.16	0.36
y3	in the same county	1274	0.09	0.29
y4	in the different county	1274	0.04	0.19
	Dummy variables for distance to			

	husband's mother-in-law (Kilometre)			
xx1	=0	1274	0.09	0.28
xx2	>0 and <20	1274	0.71	0.47
xx3	>=20	1274	0.20	0.40
	Dummy variables for trip time to husband's mother-in-law			
tt1	=0	1274	0.08	0.28
tt2	>0 and <150	1274	0.83	0.38
tt3	>=150 minutes	1274	0.09	0.29

Table 4.3: Regression of the Ratio of Body Mass Index between Husband and Wife against Location of Mother-in-Law

lhwq	Coef.	t	Coef.	t
x1			-0.085	-2.05
x2			-0.078	-2.27
x3			-0.101	-3.48
x4	0.095	3.35		
wa1	0.043	0.84	0.044	0.86
wa2	-0.010	-0.26	-0.012	-0.33
wa3	0.058	1.83	0.055	1.75
wa4	0.068	0.64	0.060	0.57
ha1	0.004	0.09	0.006	0.15
ha2	0.002	0.05	0.004	0.11
ha3	-0.045	-1.60	-0.043	-1.53
ha4	0.088	1.42	0.089	1.44
hsch	0.006	0.63	0.006	0.63
hschs	0.000	-0.50	0.000	-0.51
wsch	-0.004	-0.60	-0.005	-0.65
wschs	0.001	1.20	0.001	1.24
hage	0.012	1.00	0.011	0.94
hages	0.000	-1.32	0.000	-1.27
wage	-0.011	-1.67	-0.011	-1.61
wages	0.000	2.64	0.000	2.59
r1	-0.031	-0.93	-0.026	-0.78
r2	-0.019	-0.57	-0.015	-0.44
r3	-0.040	-1.09	-0.034	-0.93
r4	-0.036	-1.09	-0.033	-1.01
r5	-0.022	-0.69	-0.017	-0.52
r6	-0.023	-0.63	-0.020	-0.53
r7	0.023	0.58	0.027	0.66
_cons	-0.018	-0.10	0.081	0.42
N	948		948	
R sq	0.05		0.051	

Note: r1-r7 are dummy variables for provinces.

Table 4.4: Regression of Ratio of Calorie and Protein Intake between Husband and Wife

	Ratio of calorie intake		Ratio of protein intake	
lhwcal	Coef.	t	Coef.	t
x1	-0.047	-1.65	-0.050	-1.60
x2	-0.017	-0.74	-0.026	-1.01
x3	-0.020	-1.03	-0.027	-1.26
wa1	0.017	0.49	-0.034	-0.89
wa2	0.028	1.11	0.025	0.93
wa3	-0.026	-1.20	-0.002	-0.07
wa4	-0.138	-1.96	-0.139	-1.79
ha1	-0.022	-0.77	0.036	1.14
ha2	-0.076	-2.82	-0.091	-3.08
ha3	-0.004	-0.18	-0.028	-1.30
ha4	0.035	0.86	0.012	0.26
hsch	-0.003	-0.40	-0.006	-0.79
hschs	0.000	0.01	0.000	0.53
wsch	0.000	-0.06	-0.002	-0.29
wschs	0.000	0.61	0.000	0.73
hage	-0.002	-0.27	-0.003	-0.29
hages	0.000	0.20	0.000	0.20
wage	0.014	3.09	0.015	3.07
wages	0.000	-4.16	0.000	-4.13
lhwh	0.152	2.12	0.118	1.51
lhweight	0.162	4.10	0.168	3.89
lwweight	-0.159	-3.72	-0.122	-2.61
_cons	-0.075	-0.32	-0.244	-0.95
N	909		909	
R sq	0.1		0.09	

Table 4.5: Regression of Wife's Demand for Calories and Protein

	Calorie intake		Protein intake	
lwcal91	Coef.	t	Coef.	t
x1	-0.026	-1.01	-0.050	-1.52
x2	0.007	0.39	-0.009	-0.38
x4	-0.037	-1.62	-0.055	-1.90
wa1	-0.032	-0.85	-0.016	-0.34
wa2	-0.018	-0.66	-0.025	-0.73
wa3	0.045	2.05	-0.024	-0.85
wa4	0.087	1.00	0.072	0.65
wsch	-0.003	-0.51	0.000	0.01
wschs	0.000	-0.84	0.000	-0.79
wage	-0.006	-1.80	-0.002	-0.40
wages	0.000	1.50	0.000	0.11
lwheight	0.620	3.13	0.884	3.50
r1	0.025	0.97	0.127	3.84
r2	-0.016	-0.62	0.109	3.32
r3	0.104	3.75	0.179	5.08
r4	0.090	3.46	0.136	4.11
r5	0.003	0.13	0.088	2.64
r6	-0.068	-2.33	0.009	0.24
r7	0.046	1.35	0.065	1.51
_cons	4.873	4.71	-0.137	-0.10
N	1076		1076	
R sq	0.114		0.073	

Table 4.6: Regression of Husband's Demand for Calories and Protein

	Calorie intake		Protein intake	
lhcal91	Coef.	t	Coef.	t
x1	-0.054	-1.94	-0.066	-1.86
x2	0.002	0.12	-0.016	-0.63
x4	-0.018	-0.77	-0.006	-0.21
ha1	-0.076	-2.33	-0.092	-2.23
ha2	-0.076	-2.53	-0.055	-1.45
ha3	0.031	1.56	-0.017	-0.67
ha4	0.113	2.29	0.099	1.58
hsch	0.002	0.27	-0.008	-0.87
hschs	0.000	-0.23	0.001	1.39
hage	-0.001	-0.18	-0.001	-0.13
hages	0.000	-0.09	0.000	-0.01
lhheight	0.070	0.76	0.189	1.63
r1	0.024	0.91	0.114	3.39
r2	-0.016	-0.59	0.102	3.02
r3	0.154	5.23	0.246	6.55
r4	0.082	3.15	0.133	4.03
r5	0.001	0.05	0.049	1.46
r6	-0.089	-3.05	-0.037	-0.99
r7	0.057	1.71	0.045	1.07
_cons	7.666	15.64	3.462	5.55
N	954		954	
R sq	0.129		0.096	

Table 4.7: Regression of BMI Ratio with Location of Husband's Parents

lhwq	Coef.	t
x4	0.100	3.49
y1	0.002	0.11
y2	0.021	0.80
y3	-0.002	-0.04
wa1	0.051	0.99
wa2	-0.014	-0.38
wa3	0.045	1.41
wa4	0.051	0.48
ha1	0.004	0.11
ha2	-0.001	-0.02
ha3	-0.050	-1.80
ha4	0.086	1.38
hedu1	-0.013	-0.44
hedu2	0.012	0.51
hedu3	-0.008	-0.26
hedu4	0.044	0.77
wedu1	0.027	1.09
wedu2	0.016	0.64
wedu3	0.052	1.49
wedu4	-0.027	-0.39
r1	-0.033	-0.98
r2	-0.029	-0.86
r3	-0.050	-1.34
r4	-0.044	-1.33
r5	-0.016	-0.48
r6	-0.017	-0.45
r7	0.019	0.47
hage	-0.008	-0.88
hages	0.000	0.20
wage	0.005	1.65
_cons	0.104	0.56
N	948	
R sq	0.04	

Table 4.8: Regression of Calorie and Protein Ratio with Dummy of Husband's Parents

	Ratio of calorie		Ratio of protein	
lhwcal	Coef.	t	Coef.	t
x1	-0.046	-1.63	-0.049	-1.57
x2	-0.014	-0.62	-0.021	-0.84
x3	-0.018	-0.92	-0.023	-1.08
y1	-0.002	-0.15	-0.012	-0.77
y2	-0.017	-0.95	-0.026	-1.35
y3	-0.033	-1.35	-0.060	-2.21
wa1	0.018	0.51	-0.033	-0.86
wa2	0.029	1.16	0.027	0.98
wa3	-0.028	-1.29	-0.004	-0.18
wa4	-0.140	-1.99	-0.145	-1.87
ha1	-0.019	-0.67	0.040	1.27
ha2	-0.076	-2.81	-0.090	-3.06
ha3	-0.003	-0.15	-0.028	-1.30
ha4	0.036	0.87	0.014	0.30
hsch	-0.003	-0.47	-0.006	-0.84
hschs	0.000	0.06	0.000	0.58
wsch	0.000	-0.06	-0.002	-0.34
wschs	0.000	0.67	0.000	0.85
hage	-0.002	-0.22	-0.002	-0.21
hages	0.000	0.11	0.000	0.07
wage	0.014	3.10	0.015	3.07
wages	0.000	-4.16	0.000	-4.11
lhwh	0.152	2.12	0.121	1.53
lhweight	0.163	4.12	0.171	3.95
lwweight	-0.161	-3.76	-0.126	-2.68
_cons	-0.070	-0.30	-0.235	-0.91
N	909		909	
R sq	0.104		0.113	

Table 4.9: Regression of Ratio of BMI Using New Dummies

lhwq	Coef.	t
xx1	-0.005	-0.17
xx3	0.022	0.96
wa1	0.035	0.68
wa2	-0.015	-0.41
wa3	0.054	1.67
wa4	0.073	0.68
ha1	0.005	0.13
ha2	0.003	0.07
ha3	-0.044	-1.56
ha4	0.089	1.42
hsch	0.006	0.58
hschs	0.000	-0.50
wsch	-0.004	-0.59
wschs	0.001	1.22
hage	0.016	1.32
hages	0.000	-1.62
wage	-0.012	-1.88
wages	0.000	2.79
r1	-0.028	-0.85
r2	-0.020	-0.60
r3	-0.038	-1.04
r4	-0.030	-0.90
r5	-0.021	-0.64
r6	-0.026	-0.69
r7	0.026	0.63
_cons	-0.051	-0.27
N	948	
R sq	0.04	

Table 4.10: Regression Using New Dummies for the Location of Mothers-in-Law

	Ratio of calorie intake		Ratio of protein intake	
lhwcal	Coef.	t	Coef.	t
xx1	-0.027	-1.28	-0.027	-1.19
xx3	0.030	1.94	0.033	1.99
wa1	0.017	0.51	-0.033	-0.88
wa2	0.027	1.10	0.025	0.91
wa3	-0.023	-1.07	0.001	0.04
wa4	-0.127	-1.80	-0.127	-1.65
ha1	-0.022	-0.78	0.036	1.14
ha2	-0.073	-2.75	-0.088	-2.99
ha3	-0.003	-0.15	-0.027	-1.26
ha4	0.039	0.95	0.015	0.33
hsch	-0.003	-0.43	-0.006	-0.82
hschs	0.000	0.05	0.000	0.56
wsch	0.000	0.01	-0.001	-0.22
wschs	0.000	0.51	0.000	0.63
hage	-0.001	-0.15	-0.001	-0.14
hages	0.000	0.07	0.000	0.06
wage	0.013	3.03	0.014	3.00
wages	0.000	-4.10	0.000	-4.05
lhwh	0.153	2.14	0.119	1.52
lhweight	0.166	4.22	0.174	4.03
lwweight	-0.154	-3.61	-0.118	-2.51
_cons	-0.148	-0.63	-0.331	-1.28
N	909		909	
R sq	0.105		0.093	

Table 4.11: Regression Using Time Spent on Travelling to Mother-in-Law's Home

lhwq	Coef.	t
tt1	0.004	0.12
tt3	0.067	1.94
wa1	0.022	0.42
wa2	-0.027	-0.74
wa3	0.043	1.34
wa4	0.060	0.55
ha1	0.017	0.40
ha2	0.004	0.11
ha3	-0.044	-1.55
ha4	0.091	1.45
hsch	0.004	0.42
hschs	0.000	-0.34
wsch	-0.005	-0.67
wschs	0.001	1.36
r1	-0.020	-0.59
r2	-0.017	-0.50
r3	-0.039	-1.06
r4	-0.027	-0.81
r5	-0.012	-0.35
r6	-0.014	-0.39
r7	0.029	0.70
hage	-0.006	-0.64
hages	0.000	0.03
wage	0.004	1.54
_cons	0.055	0.29
N	948	
R sq	0.035	

Table 4.12: Regression Using Time Spent on Travelling to Mothers-in-Law's Home

	Ratio of calorie intake		Ratio of calorie intake	
lhwcal	Coef.	t	Coef.	t
tt1	-0.033	-1.60	-0.031	-1.34
tt3	0.024	1.04	0.028	1.13
wa1	0.016	0.45	-0.035	-0.94
wa2	0.027	1.09	0.024	0.89
wa3	-0.026	-1.20	-0.003	-0.10
wa4	-0.131	-1.87	-0.132	-1.72
ha1	-0.022	-0.76	0.036	1.16
ha2	-0.075	-2.80	-0.090	-3.05
ha3	-0.004	-0.19	-0.028	-1.30
ha4	0.036	0.87	0.012	0.26
hsch	-0.003	-0.42	-0.006	-0.80
hschs	0.000	0.03	0.000	0.54
wsch	0.000	-0.05	-0.001	-0.29
wschs	0.000	0.64	0.000	0.77
hage	-0.002	-0.24	-0.002	-0.24
hages	0.000	0.18	0.000	0.18
wage	0.013	3.05	0.015	3.02
wages	0.000	-4.14	0.000	-4.10
lhwh	0.152	2.12	0.118	1.50
lhweight	0.163	4.15	0.171	3.95
lwweight	-0.161	-3.78	-0.125	-2.68
_cons	-0.091	-0.39	-0.268	-1.04
N	909		909	
R sq	0.1		0.09	

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Chapter 5

Risk and Consumption Insurance against Income Change in China

5.1 Introduction

Consumption insurance has attracted considerable attention in the last ten years. The full consumption hypothesis is that consumption patterns of individual households should not respond to idiosyncratic income or wealth shocks. The underlying condition for full consumption insurance is that markets are complete, although competitive markets in explicit contingent claims are not necessary to implement consumption-insured allocations because certain formal or informal institutions can also provide consumption insurance. The term "formal institution" refers to structures such as the credit market, unemployment, disability, and medical insurance, welfare and other government social programs. "Informal institutions" include gifts, loans from family networks, friends and neighbours, some altruistic inter-generation transfers and the underground credit market. A large number of empirical studies (Cochrane 1991; Alderman and Paxson 1994; Besley 1995; Deaton 1992; Morduch 1995 and Townsend 1994, 1995) have found that income risk is pervasive, but that consumers are able to protect consumption from risk, at least partially, through both formal and informal institutional arrangements.

"Do formal insurance arrangements for consumption insurance work better than informal institutional arrangements?" Formal institutional arrangements (particularly those implemented by government) have some advantages. However, problems such as inefficiency of bureaucracy, or the weak fiscal position of government may lead to insufficiencies in the provision of government insurance. In contrast, informal institutional arrangements may be more efficient if they can survive in the market place. However, it is recognised that moral hazard and enforcement problems may weaken or destroy informal insurance arrangements. In this chapter, I consider the extent to which informal institutions in China help consumers to insure their consumption against risks. Can informal institutions work over a long physical spatial distance? Are informal institutions subject to serious information problems?

These matters are of interest for several reasons. Firstly, in a developing economy, many workers are left exposed to risk, their incomes are volatile, and their earnings are very low. Consequently, the gap between "good times" and malnutrition, disease and even starvation is slight. Consumers in these developing economies also lack access to formal insurance and credit markets. Given these factors, it is important to examine how and, to what extent, consumers can adjust their consumption when facing idiosyncratic shocks.

Secondly, governments and non-government organisations have implemented various programs such as credit schemes and crop insurance schemes to help consumers shield consumption from income risks. If, however, informal insurance arrangements work well, are governmental programs necessary? Government programs might just crowd out the existing informal insurance arrangements. Chinese policy analysts and policy makers are reluctant to extend the social security system (pensions and medical insurance) to cover the rural population, because they believe that family networks are effective in protecting consumption from risk in these areas. Is this true?

Thirdly, in 1986, the Chinese government declared that 272 counties were nationally poor counties and targeted substantial aid programs to them. The argument for this strategy was that consumers are able to share risks within the county through informal arrangements, but informal arrangements cannot manage risk at the county level. The scope of insurance based on informal arrangements is a key input in this policy debate.

Comparing the performance of formal and informal insurance arrangements is very difficult. Most research on consumption insurance has applied the general equilibrium framework, which has led researchers to focus on outcomes, namely, consumption and labour supply. As a result, all kinds of insurance institutions have been jointly evaluated. If we look at the risk sharing institutions, one at a time, the possibilities for adjustment in consumption, provided by the complete set of institutions may be missed. This is why the general equilibrium method dominates in the study of consumption insurance. However, within the framework of general equilibrium, how can we compare the performances of formal and informal arrangements?

Fortunately, the special social-economic structure of the Chinese economy provides a natural laboratory for us to evaluate to some extent the relative performance of both formal and informal insurance arrangements.

We can test full consumption insurance for rural and urban samples in China separately, because migration was severely restriction between rural and urban areas for a long period (Meng 1999). Before the 1980s, all the migration between rural and urban areas was completely controlled by the government and there were very few means (such as going into university), by which rural people could move to the cities. The amount of migration between rural and urban areas remained very small until the beginning of the 1990s.

The population in the rural and the urban areas in China have very different consumption insurance mechanisms. During the transition period (i.e. the change from a planned economy to a market economy), no formal financial market or social security system has been available to rural households. As a result, households in rural areas have had to rely on informal institutional arrangements such as charities, gifts and loans in family networks, or production diversification, to guard against risk. However, urban households still enjoy many government insurance programs, such as pension systems, medical insurance, collective medical insurance and unemployment insurance.

The comparison of the extent of consumption insurance between rural and urban samples provides some evidence of the different effects of formal and informal insurance mechanisms. However, the quality of this study will depend on a number of conditions. Firstly, there must be neither migration nor risk sharing between the rural and urban groups. Secondly, the comparison requires that the urban population has exclusive access to the formal insurance mechanism only, and that the rural population can access only the informal insurance mechanisms. Although these restrictions must be strictly applied, we can still obtain some very useful information from comparisons between Chinese rural and urban areas as long as the majority of governmental insurance programs cover only the urban population.

We investigated the extent of consumption insurance in post-reform China between 1989-1993 using a unique panel data set from the (CHNS) which contains excellent measures of income and consumption data. This data set also allows evaluation of the scope of informal insurance arrangements. Theoretically, information problems and enforcement problems affect the provision of insurance by informal institutional arrangements. It is believed that these problems become more serious with the increase of physical distance between individuals. In addition, higher transaction costs may prohibit the availability of market insurance between regions. However, information transfer problems can be solved for some small groups of people, for instance, at village level. Most Chinese villages were formed a long time ago and many families have remained in the same place for generations and villagers usually have the same ancestry. Many contemporary residents live, eat and work in the village. Villages have their own distinct lifestyle and informal legal systems that are replete with contract enforcement mechanisms. In addition, village residents have relatively good information about the ability, effort and reputation of village inhabitants. On this basis, we are able to study forms of consumption insurance within and across villages. This test has important implications for the theory of full insurance because it can tell us if insurance deteriorates with distance. The empirical evidence derived from within and between villages will lead us to understand how insurance is affected by information transfer problems such as moral hazard.

A direct policy implication of this chapter relates to the necessity of extending a government operated social security system to rural areas. With deep reforms characterised as "decentralisation and privatisation", recent reform proposals begin by emphasising the design of a more modern and financially viable social security system for people in urban areas. One of the most striking features of current policy discussion is the lack of attention paid to the majority of the population who live in rural areas. It is argued that family values remain strong in rural areas, and traditional *morality* helps to maintain the informal network through which rural people insure each other. Furthermore, some have argued that any form of public insurance will serve to undermine whatever informal arrangements currently exist. Unfortunately this debate is completely without an empirical foundation. This chapter offers some evidence by comparing the effects of insurance provided by both formal and informal institutions but cannot comment on the *crowding out* premise. Testing whether and, to what extent, household consumption responds to the risk of change in income, has important policy implications. If welfare lost due to the lack of full consumption insurance is very large, future reform should shift to the establishment of a formal social security system.

Testing full consumption insurance also has methodological implications for macroeconomics and finance. Full insurance implies the existence of a representative consumer, that is, a social welfare function defined over aggregates that are independent of changes in the distribution of income or wealth over time. The failure of full consumption insurance suggests the rejection of a representative consumer model. Furthermore, the test of full insurance also sheds light on the research of savings behaviour, which has recently attracted attention of economists and policy makers in China.

In this chapter, I firstly test insuring consumption against income changes and compare the extent of insurance between different population groups. I then move to test insuring consumption against income change for sample villages. This might be the first paper to conduct these two tests by using one data set in one economy. The findings are as follows:

--Full insurance hypothesis cannot be rejected in urban areas.

--Full insurance is rejected for the rural sample.

--Full insurance cannot be rejected within the village.

--Full insurance is completely rejected across sample villages or neighbourhoods.

This chapter is organised as follows. Section 5.2 is a short literature review; section 5.3 discusses the institutional setting during the transition period in China and the relevant aspects of production, income and risk. Section 5.4 describes the theoretical model. Section 5.5 discusses model specifications and econometric issues; section 5.6 then presents the description of the data and discusses the empirical results. The last section presents a short conclusion.

5.2 Literature Review

People living in developing countries face substantial risks such as volatile incomes, sickness, crop disease and weather shocks. These factors are usually beyond the control of individual farmers and leave them exposed to risks. Reducing (i.e. smoothing) household consumption in response to these shocks has important welfare implications, particularly for people with low incomes. Finding ways to smooth out their consumption can mean the difference between life and death for many individuals.

Households in developing countries usually lack access to formal insurance and credit markets. The question is: whether and to what extent can households in a low-income economy smooth their consumption in the face of major shocks, even without access to formal credit markets? Risk sharing and consumption smoothing has received a great deal of attention from development economists in the last ten years or so.

The full risk sharing concept has been derived from work done by Debreu (1959) Diamond (1967) and Wilson (1968). Their theory posits that household consumption will not respond to idiosyncratic shocks. The basic idea is that if households are risk averse and if actuarially fair insurance is available, they will choose to buy insurance. In addition, if these risks are idiosyncratic, risk averse households ought to group together to share all risks. Idiosyncratic risks include the weather, shocks associated with the incidence of crop disease and human illness, shocks associated with changes in prices, outside the group or the local economy, and random factors which determine births, deaths, migration and division of extended families. If risks are fully pooled, then the growth in household consumption should track the growth of group average consumption, and nothing else. In other words, the movement of average group consumption represents aggregate risk and all other shocks are pooled through risk sharing mechanisms.

To test the extent of consumption insurance, we need evidence on whether the income or wealth risks that facing consumers is insurable within the group. If individual income co-varies too much, in the extreme, common to the population, insurance within the group must be limited. Therefore, it is important to understand what income fluctuations occur in developing countries and whether they are idiosyncratic to the household. In the history of development economics, the literature usually assumes that risks are co-varied, i.e. all of the people are doing the same thing and face a common risk. Actually this assumption appears not to represent the facts. Townsend (1994) used ICRISAT [21]data to show that individual household incomes vary considerably over time from the village average. To understand the presumption of covariant risk, Townsend also calculates the variance-covariance matrices of net income from different sources. His findings are that income does not co-move across households in each of these villages because households earn their income from various ways and face different risks. Lim (1992) also analyses this data by applying a factor model to household incomes. He found that there are some unobserved factors that drive income across households. After accounting for these unobserved factors, Lim attributed 25% of the income variance to residual, household-specific, idiosyncratic items. A similar story of the idiosyncratic variability of income

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[21] The ICRISAT (International Crops Research Institute For the Semi-Arid Tropics) data comes from a special survey in which up to 40 households were sampled almost continuously, month to month, in each of three villages for 10 years.

emerges for households in villages in the Cote d'Ivoire (Deaton 1992). There is considerable diversity in growth rates across counties in a given region over a given pair of years.

The literature mentioned above suggests that there is considerable scope for co-insurance within the group because many risks are idiosyncratic. However, is full consumption insurance available? To answer this question, researchers have compared the regression of individual household consumption growth against average group consumption growth, the growth of specific incomes of each household and shocks such as unemployment and sickness. If risk sharing is complete, the coefficient on group consumption change will be one, and the coefficient of household income and any other shocks will be zero.

Townsend's paper (1994) is the best known of these studies, using ICRISAT data to set up a regression in which the dependent variable is the change in household consumption relative to the village average. He found a relatively low influence of current household income on current household consumption. The marginal propensity for a household to consume out of idiosyncratic changes in income was no greater than 0.14 in any of three villages[22]. Townsend also extended his model to explore the sensitivity of consumption to other shocks. Unexpectedly, he found that neither unemployment nor sickness was found to impact on household consumption. He also found that landless households are significantly less well insured than their village neighbours, who had land. In another paper, Townsend (1995) reported on a similar survey conducted in the context of the

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[22] For the United States, Mace used data from PSID and found a positive and significant coefficient of 0.1 to 0.2.

whole of Thailand. The dependent variable was designated as the change in average county consumption (in log form); the independent variables were the change in average log county income and the change in regional average consumption. From his results, the full insurance hypothesis can be overwhelmingly rejected because consumption in a county does move with income in that county. The idiosyncratic county-specific income coefficient was quite high, from 0.33 to 0.37 across regions. Attanasio and Davis (1996) analysed how relative wage movements among birth cohorts and education groups affect the distribution of household consumption and economic welfare and they found a spectacular failure of between-group consumption insurance. In contrast, Paxson (1992) found that households are able to smooth consumption across weather variability through savings decisions. Paxson ran a regression of savings against the measure of weather and her work showed a coefficient of transitory income close to one (0.73 and 0.83).

Although the results of the test for full consumption insurance are mixed, most tests indeed show the existence of more consumption insurance than might have been anticipated. These studies, however, do not identify how consumption is smoothed in reality. Lim and Townsend (1998) constructed measurements for changes in farm inventory, real asset, currency and financial assets from the ICRISAT transaction and production files. Their findings show that purchases and sales of real capital assets do not play an important role in smoothing income fluctuations. On the other hand, crop inventories play a relatively large role in the monthly and annual data. Relatively large landholders tend to use crop inventory while landless households use currency. Rosenzweig (Rosenzweig 1988, Rosenzweig and Stark 1989) found that households seem to deliberately marry-off daughters over a space-in-time to provide insurance. His paper sheds light on this informal risk sharing arrangement among family members.

These findings show that many kinds of informal insurance arrangements contribute to consumption insurance in developing countries. Besley (1995) provides an excellent survey of research on non-market institutions providing credit and risk sharing opportunities in low-income countries. He found that informal institutional arrangements (which he calls non-market institutions) such as credit cooperation, informal credit, rotating savings and credit associations, help consumers protect themselves against risks.

5.3 Institutional Background

To discuss risk sharing in the Chinese economy, we need to document the institutional background of China. During the period 1989 to 1993, during which our sample was observed, China's economy was transforming from a planned economy to a market economy. Since 1949, China had pursued a Stalinist economy, whereby assets and property belonged to the people (i.e. to the government) and there existed no conventional labour market. Labour was thus not considered to be a commodity and wages were not perceived to be the price of labour. The government controlled the allocation of resources in the economy and risk sharing was arranged by government planners. The principle of income distribution was to share the yield from production as equally as possible among the population. There was no necessarily to share risk within the community for the residents.

One of the most striking irregularities about the institutional background of consumption insurance in China, is the strict division between rural and urban areas. For instance, almost all government insurance programs, such as unemployment insurance, pension systems, medical insurance, food support and so forth cover only the urban population and not the rural population. This kind of institutional background offers us a great opportunity to test the performance of formal (particular by government) and informal risk insurance arrangements. We can do this just by studying the extent of consumption risk insurance for rural and urban populations separately and comparing them. The underlying assumption is that rural consumers insure their consumption only through informal measures and urban consumers insure through formal arrangements.

5.3.1 Risk sharing in rural areas

To implement the Stalinist economic model, the Chinese government conducted a strategy of mutually exclusive rural and urban economies and rural people were excluded from working and living in the cities. During the commune movement in the 1950s, rural people were organised as a single entity: the commune. On average, communes consisted of 5,000 households. An attempt was made to apply the communist principles of production and income distribution: " from each according to their ability, to each according to their needs". There existed no risk sharing problem between households within the same commune. At the same time, substantial risk sharing arrangements across communes were implemented by higher-level government agencies and these were controlled at county or provincial level. Early in the 1960's, the commune movement faced economic disaster due to the lack of an appropriate incentive system. After the economic catastrophe of the 1960s, the commune system was modified and a "three tiered" system implemented to correspond with the three administrative hierarchies:

communes, brigades and production teams. The brigade (about 200 households) became the basic accounting unit. Under this system, most income and agriculture production was distributed more or less equally and a small portion was distributed as rewards for effort. Under this arrangement, there was almost full insurance among households within brigades or production teams. At the higher government level, communes and counties still implemented some insurance among brigades and communes by reallocating resources with no compensation.

However, under the commune, brigades and production team system, the rewards for individual work were still not tied directly to effort, and the incentive to work was thus very low. From 1978 onward, the government subdivided collectively owned land into individual household farms to improve farmer's incentive. By the end of 1983, 98% of the production teams had adopted the household responsibility system (HRS). Under the HRS, collectively owned land and other resources were assigned to individual households with contracts of 15 years. These contracts were extended to 30-50 years when they were renewed in the 1990s. The other most important element of these reforms was the greater role given to markets in guiding agricultural production. During the post-reform period, the problem of risk sharing became very serious for individual households that now had to cope with a variety of risks. The brigade and production teams could no longer offer insurance for their members because all resources were now assigned to individual households.

In fact, for some policy makers in the early of 1980s, their rejection of the HRS was attributed to the problems associated with risk sharing. In rural areas, some households with less strong household members retained the old production team system. Some policy makers argued that families that were in a weak position would suffer from the introduction of the newly agriculture system. This debate had continued up to the present and evaluation of the degree of full insurance in rural areas of China has direct policy implications.

5.3.2 Risk sharing in urban area

From the 1950s, the Chinese government completely controlled allocation of economic resources in a Marxist construct. According to Marxist theory, workers are the ultimate owners of property, and they can obtain jobs whenever they are needed. In addition, no-one can dismiss anyone else. Under this doctrine, full employment and lifetime tenure are the fundamentals on which economic security is based.

Wages in the urban areas were also centrally determined and controlled by the government and enterprises were not financially independent. The government introduced a graded wage system, which reflected education, seniority and regional differences. Wage increases were awarded only according to government regulations.
To keep wages low and rigid, most welfare benefits—such as housing, medical care, pensions and schooling were provided by state-owned enterprises as an internal social security system.

It is clear that, in the planned economy, urban households faced a much lower income risk than rural households. However such a system cannot offer a proper incentive system. Encouraged by the success in rural area reform, the government began to take a bolder approach to reforms in the urban sector. Markets were given a greater role in determining prices of output, wages, and employment numbers. During 1989-1993, when our sample was collected, urban households lived in a more competitive and risky environment compared with the period preceding the reforms and interest in consumption insurance increased.

5.3.3 The Separation of rural and urban areas

The difference between institutional insurance arrangements in the rural and urban areas is very significant. Table 5.1 compares insurance arrangements in rural and urban areas.

Table 5.1: Comparison of Insurance Arrangements in Rural and Urban Areas

		Rural	Urban
Government programs	Unemployment insurance	No	Yes
	Public medical insurance	No	Yes
	Worker medical insurance	No	Yes
	Work unit medical insurance	No	Yes
	Food subsidies	No	Yes
	Pension system	No	Yes
Informal		Yes	Not clear
Formal credit and insurance market		Very difficult	Yes

The division of rural and urban areas is implemented by the "hukou" system (household registration system). Under this system, individuals are forced to register with local authorities to gain residency, thereby determining where they live and work. Migration between rural and urban areas was severely restricted.

In the context of the Chinese economy, we are interested in the following questions:

How well developed are institutions that might insure people during the transition period of the Chinese economy?

Are there differences in the amount of insurance available between the rural and urban samples?

If there is some insurance, at which level does this insurance occur: village level, regional level or national level?

Can we find evidence of a relationship between insurance and geographical distance?

From the description of China's institutional background, we could predict that urban households are likely to enjoy more insurance than rural households, because of the absence of a formal insurance system and formal credit market in rural areas. It is also difficult for rural area households to co-insure each other across villages. However, there are a variety of informal institutional insurance arrangements within villages that could be very effective in helping individuals to insure each other.

5.4 The Theoretical Model

Consider a pure exchange economy with N members. An individual's time separable expected utility function over a single consumption good can be written as:

$$\sum_{t=0}^{\infty} \rho^t \sum_{\tau}^{S} \pi(s_\pi) U(c_t^j(s_\pi), b_t^j(s_\pi)) \quad (5\text{-}1)$$

Where $c_t^j(s_\pi)$ is consumption for individual j in event τ at time t, $b_t^j(s_\pi)$ is a preference shock, and $0 < \rho < 1$ the discount factor.

The Pareto-optimal consumption allocation is derived from the planning problem, Maximize a weighted sum of individual household utilities:

$$Max \sum_{j=1}^{N} \lambda^j \sum_{t=0}^{\infty} \rho^t \sum_{\tau}^{S} \pi(s_\pi) U(c_t^j(s_\pi), b_t^j(s_\pi)) \quad (5\text{-}2)$$

where λ^j is Pareto weight associated with individual j.

The feasibility constraint is that aggregate consumption must be less than the aggregate endowment, at each date and in each state:

$$(5\text{-}3)$$

$$\text{s.t. } c^a(s_\pi) = \sum_j c^j(s_\pi) <= \sum_j e^j(s_\pi) \quad \text{for all } s_\pi$$

where the left hand side is the total consumption of N members and the right hand side is total endowment available at time t. The reason is that the planner can solve a plan with production by first determining the optimal distribution of aggregate goods across dates and states, and then determining how to distribute those aggregate goods, acting as though they were endowments.

The first order condition for the planner's maximization problem is:

$$(\rho^j)^t \lambda^j u_c(c_t^j, b_t^j) = \mu_t \text{ for all } s_\pi . \qquad (5\text{-}4)$$

The left-hand side is the discounted weighted marginal utility. The right hand side is the Lagrange multiplier associated with the feasibility constraint (5-3), divided by the probability of state s_π. The right hand side depends on aggregate consumption. It is constant across household j. The individual household's endowment does not enter into the determination of individual household's consumption allocations, given aggregate consumption and the Pareto weights.

In the first order conditions, the Pareto weight is not observable by the econometrician. This problem can be solved, by dividing the first order condition at two points in time. Hence, panel data (at least two time points) is required to test the full insurance hypothesis.

$$\rho^j \frac{u_c(c_{t+1}^j, b_{t+1}^j)}{u_c(c_t^j, b_t^j)} = \frac{\mu_{t+1}}{\mu_t} \qquad (5\text{-}5)$$

This equation shows that the growth of marginal utility of individual j is constant across households. Given aggregate consumption, individual household endowment has nothing to do with the determination of the growth of discounted individual household marginal utility.

Now suppose the utility function is a CRRA utility function

$$U = b_t^j \frac{1}{\sigma^j}(c_t^j)^{\sigma^j} \tag{5-6}$$

Substituting (5-6) into condition (5-5), and take logs, we get

$$\log(\frac{c_{t+1}^j}{c_t^j}) = \frac{1}{\sigma^j - 1}(\log(\frac{\mu_{t+1}}{\mu_t}) - (\log\frac{b_{t+1}^j}{b_t^j}) - \log(\rho^j)) \tag{5-7}$$

This equation indicates that the growth of consumption for individual household j is determined by the risk aversion coefficient, preference shifter, time preference, and the refined Lagrange multiplier. All of these factors can be captured by a constant item in a statistical model. When we consider any variable that represents the idiosyncratic shocks, it will be independent of consumption growth if this idiosyncratic variable is cross-sectionally independent.

To test full consumption insurance, we consider a statistical form of (5-7),

$$\log(\frac{c_{t+1}^j}{c_t^j}) = \alpha + \beta\Delta X_{t+1}^j + \gamma A_t^j + \varepsilon_{t+1}^j \tag{5-8}$$

where A_t^j is the demographic term correlated with preference shift, ΔX_t^j are idiosyncratic shock variables such as income changes. According to our model, these variables should not enter into the determination of increases in consumption.

We also have an alternative form of (5-7). By substituting utility function (5-6) into (5-4), adding the first order condition over individual household j in village or neighbourhood v, one obtains a formula as follows:

$$\log(\frac{c_{t+1}^{j}}{c_{t}^{j}}) = \log(\frac{c_{t+1}}{c_{t}})^{v} + \frac{\sigma}{1-\sigma}(b_{t+1}^{j} - b_{t}^{j}) - (b_{t+1}^{v} - b_{t}^{v}), \quad v = 1,2,...V \tag{5-9}$$

Where $\log(\frac{c_{t+1}}{c_{t}})^{v} = \frac{1}{N_{v}}\sum_{j}^{N_{v}}\log(\frac{c_{t+1}^{j}}{c_{t}^{j}}) \equiv c^{v}$,

Therefore we have an alternative reduced form version:

$$\log(\frac{c_{t+1}^{j}}{c_{t}^{j}}) = \alpha + \delta c^{v} + \beta \Delta X_{t+1}^{j} + \gamma A_{t}^{j} + \varepsilon_{t+1}^{j} \tag{5-10}$$

Specification and empirical applications:

In both equation (5-8) and equation (5-10), ΔX_{t+1}^{j} is the change of income or the change of health status. The coefficient of these variables is predicted as zero by the model. Actually, to match the test exactly to the model requires data on a measure of income that has not been insured. When we use total income, it is possible that some risk sharing has taken place and is included in the measure of income, for instance, the total household income may include welfare benefits from a social security program, interest income, various lump-sum receipts, gifts and transfer etc[23].

[23] We are assuming that consumption insurance does not take place through income insurance. If that is the process of insurance, our empirical test in this chapter will overstate the ability of consumption insurance. Chapter 6 will discuss it in details.

In equation (5-13), the risk sharing model predicts that θ =1 and β=0.

5.5 Specification and Econometric Issues

In this section we show that the separability, power form, and restrictions on individual heterogeneity in the example above are not essential to the full insurance proposition.

5.5.1 Separability problem

Equation (5-8) is robust to the non-separability assumption. This becomes obvious when we write the planning problem as follows:

$$Max\sum_{j=1}^{N}\lambda^{j}\sum_{t=0}^{\infty}\rho^{t}\sum_{\tau}^{S}\pi(s_{\pi})U(c_t^j(s_{\pi}),l_t^j(s_{\pi}),b_t^j(s_{\pi}))$$

$$\text{s.t. } \sum_{j=1}^{N}c_t^j\le\sum_{j}^{N}e_t^j,\ \text{ and } \sum_{j=1}^{N}l_t^j\le\sum_{j}^{N}z_t^j, \qquad (5\text{-}11)$$

where z_t^j is endowment of leisure for individual household j at time t. We can obtain two first order conditions for consumption and leisure analogous to (5-5), respectively. Suppose the utility function is as follows:

$$U=b_t^j\frac{1}{\sigma^j}(c_t^j)^{\sigma^j}\frac{1}{\theta^j}(l_t^j)^{\theta^j} \qquad (5\text{-}12)$$

We can get consumption allocation analogous to (5-8):

$$\log(\frac{c^j_{t+1}}{c^j_t}) = \frac{1}{\sigma^j + \theta^j - 1}((1-\theta^j)\log(\frac{\mu^c_{t+1}}{\mu^c_t}) - \theta^j \log(\frac{\mu^l_{t+1}}{\mu^l_t}) - (\log\frac{b^j_{t+1}}{b^j_t}) - \log(\rho^j)) \quad (5\text{-}13)$$

where the difference between (5-13) and (5-7) is that the Lagrange multiplier associated with leisure constraints enters into the determination of the consumption allocation. Therefore, if the idiosyncratic variables are cross-sectionally independent of preference shift, time preference and the risk aversion coefficient, these idiosyncratic variables will be independent of consumption growth.

This conclusion seems to contradict traditional wisdom as to the non-separability assumption. For instance, if leisure and consumption are substitutes, less leisure will change the marginal utility of consumption and increase consumption. Therefore unemployment will correlate with consumption growth. However this is not the case, because leisure is also part of the plan and is allocated across individuals without regard to endowments. In other words, the planner simultaneously determines consumption and leisure. The key assumption behind this argument is that the planner can transfer leisure across households freely. We have to admit that it is quite a strong assumption. If this assumption fails, the qualified idiosyncratic variables, on the right hand side of equation(5-8), also need to be independent of leisure. Obviously, unemployment status does not satisfy this requirement. Although the majority of researchers use employment status as right hand side variables, (eg. Cochrane 1991 and Mace 1991), we will not use employment in this chapter.

Regarding the more general form of utility function, Cochrane (1991) argued that marginal utility growth is not just a function of consumption growth and that we may still write marginal utility growth as a function of consumption growth and initial consumption level. Additionally, if the right hand variable is independent of the initial consumption level, it should still be independent of consumption growth. Finally, if the idiosyncratic variables are cross-sectionally independent of the initial consumption level (as well as preference shifts and measurement error), these idiosyncratic variables are cross- sectionally independent of consumption growth.

5.5.2 Pooled versus cross-sectional regressions

Pooled time-series cross-sectional regressions are affected by non-separability and functional form assumptions. From equation (5-8), the error item includes factors that affect consumption growth but which are not observed by the econometrician. Amongst these factors are the shape of utility function, risk aversion, time preference and measurement error of the consumption growth rate. For instance, lower risk aversion households are likely to have a more volatile consumption path. Consequently, the right hand variable should not correlate with the above factors, over time, in pooled time series and cross sectional regression. However this correlation is difficult to satisfy. For instance, individual income is likely to be correlated over time with aggregate income and hence with the Lagrange multipliers. Townsend (1994) and Mace (1991) control for this problem by including average consumption growth of the community on the right-hand side. Cochrane (1991) pointed out several reasons for including it on the right side that may fail to control for correlation of the right hand side variable with the Lagrange multiplier. In summary, the assumptions of pooled and strictly cross-sectional regression are different. It is difficult to choose between pooled and strictly cross-sectional regression. We will offer results from both methods.

5.6 Data and results

Equation (5-8) and (5-10) are the test specifications in this section. These involve growth rate of consumption and income. This test requires a minimum of two observations for each household.

5.6.1 The Data

Data is taken from the China Health and Nutrition Surveys (CHNS) of 1989, 1991 and 1993.

Detailed household food consumption data was collected during 3 consecutive days, which were randomly allocated from Monday to Sunday and were almost equally balanced across the 7 days of the week for each sampling unit.

At the same time, the state and free market stores were visited and prices were collected for a representative basket of commodities for each community. This enabled us to construct food expenditure. The method is as follows: Firstly, food consumed by households is categorised into classes and matched against the prices collected. A total of 40 kinds of food and prices were listed. Secondly, calculation are made to obtain real food expenditure by product of 1989 prices and the quantities of food consumed in each year. There are three kinds of price: state stores price, free market price and negotiated price. We use free market price or negotiated price. If they are not available, we then use the state store price.

The income variable comes directly from the survey data. Of course, the quality test of the full insurance hypothesis depends on the quality of the income data. If there is a serious measurement error, the coefficient will be biased toward zero. However, we cannot identify between the effect of full insurance and measurement error. This is the potential weakness of this chapter. This problem cannot be solved without good instrumental variables. To confirm our test, we will test the full insurance hypothesis using an alternative shock variable such as a dummy for different illnesses. This segment of the study will be conducted in another chapter.

5.6.2 Results

We ran cross sectional regressions of consumption change against income change by using the 1989 and 1991 data. This simple and robust technique for testing consumption insurance is used in Cochrane (1991). Non-separability, functional form assumptions, and generalisations of preference shocks do not affect this test.

The regression is based on equation (5-8). The dependent variables are change of total food consumption, grain consumption and non-grain food consumption. To compare the different consumption insurance behaviour in rural areas and urban areas, the regression has been run for the total sample and two sub-samples (i.e. a rural area and urban area respectively).

In our regression, in order to capture the demographic effect, household size and the regional dummies have both been added.

The results of our test are reported in Tables 5.4.1 to Table 5.4.3. Apparently, full consumption insurance is rejected in the rural area, however it cannot be rejected in the urban area. The coefficient of income change is significantly different from zero for the rural area, but not for the urban area. The coefficients of income change in the regression of food consumption growth are 2.3%, 2.4% and 1.7% for the total sample, the rural sample and the urban sample, respectively. The coefficients are statistically significant at the 5% level for the total sample and the rural area sample, but not the urban. This is true for the regression of grain consumption and non-grain consumption. It is worth noting that the coefficients of income change are quite small. This coefficient increases to 0.04-0.05 in the regression of non-grain consumption for the total sample and rural areas. This result is consistent with the previous works. For instance, in the empirical work by Mace (1991), the elasticity of income for 12 goods in the USA is about 0.04 and significant.

The small size of the estimated coefficients shows that there is significant insurance in the Chinese economy. As we mentioned before, using income change as an idiosyncratic variable suffers several disadvantages. On one hand, income from labour supply and other sources may be neither independent from the consumption of the household nor exogenous from the decision problems facing a typical household. So it can be argued that the significance of the coefficient is not sufficient to reject the full insurance assumption. On the other hand, the measurement error of income will result in downward bias.

How does the risk insurance happen? Does it deteriorate with distance? We include village or neighbourhood average consumption growth as a right hand variable. In our total sample there are 188 villages or neighbourhoods. The results are reported in Table 5.5.1-Table 5.5.3. All of the coefficients of income change are now not statistically significant from zero for any one of the total, rural and urban samples and the coefficient of village or neighbourhood average consumption change is between 0.93-0.96. This indicates that the consumption of households indeed tracks with the village's average consumption. These results confirm that there is very significant insurance confined in villages and neighbourhoods. Recall that there is no formal credit market, insurance market or social security system in the rural areas and from this we can conclude that insurance within the village is implemented through informal mechanisms. It has been found that the exchange of labour ("huan gong") and borrowing and lending among households are very popular in Chinese villages. From our results, it seems that these informal mechanisms are doing a good job. It is worthy doing further research to investigate the conditions that help these informal markets work with such success.

If within the village and neighbourhood, households can insure each other, how about risk sharing across villages? To answer this question, regression equation (5-8) is run again for the sample villages or neighbourhoods. The dependent variable is the average change in food consumption (in log form) for households in the village (neighbourhood). The independent variable is the change in average log village income. We also try to control for population change of the village and unobserved regional type (by using a province dummy).

The results are reported in Table 5.6.1. It is apparent that the full insurance hypothesis is overwhelmingly rejected. The coefficients of village income change are 0.11, 0.08 and 0.17 for the regression of total food, grain consumption and non-grain consumption respectively and these coefficients are statistically significant. Village (neighbourhood) income changes have a significant impact on village (neighbourhood) consumption changes. However, the hypothesis that village consumption moves one to one with village income is also rejected. This means that there is a considerable amount of risk sharing but, in this case, it is much less than perfect.

We ran the same regression by including village population size change as a right hand variable, the result is reported in Table 5.6.2 and it is very similar to the result above. The coefficient of the size change ranged from 0.06 to 0.146.

The most interesting observation to be made from these results is that the idiosyncratic village-specific income coefficients are not uniformly reduced when we control for the province dummy (see Table 5.6.3). The coefficients are 0.08, 0.02 and 0.196 for the regression of total food consumption, grain consumption and non-grain consumption respectively. This result might suggest that there is little risk sharing across villages within the province.

As in section 5.5, pure cross-sectional regression, pooling time series and cross-sectional regression are based on different assumptions. To look at the robustness of our result, from the perspective of cross-sectional regression, we have re-worked the regressions in the context of a panel by using the 1989, 1991 and 1993 data. The results are reported in appendix A5.1 to A5.3.3. The results are similar to those of a cross-sectional regression. In the regression for sample villages, the coefficients become smaller.

With these results, we can partially answer the question: "does insurance deteriorate with distance?" One might hypothesise that there would be a fair degree of risk sharing at the village level (just as Townsend found in his research on Indian village data), less at the regional level, and still less at the national level. This issue has been examined by several researchers [24]. Our results show that there is a far more effective inter-household insurance support system within villages (neighbourhoods) than across villages.

This finding has important implications. It helps us to understand the reasons behind the rejection of full insurance for rural areas. For instance, our results lead us to think that information transfer problems (i.e transfer of information related to moral hazard and adverse selection) could be the cause of the failure of full insurance. The information transfer problem could disappear in the small group situation, such as in villages or neighbourhoods. In China, the village usually consists of households bearing the same family name. These households have the same ancestors and have lived closely in one village for many generations. Everyone knows each other very well and the interaction between households can be thought of as a repeated game. The reputation model guarantees that market equilibrium exists. In fact the existence of the informal credit market has a long history in Chinese villages. This could be the reason why a good risk

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[24] Rashid (1991) found the degree of insurance deteriorates with distance in Pakistan data. Crucini (1999) found that cross-state and cross-province insurance in the USA and Canada, is better than across OECD countries.

sharing system exists within villages. However, the factors we mentioned above cannot support the concept of a general credit market across villages.

In summary, our results suggest that there are quite satisfactory insurance arrangements in place within villages while regional financial markets are fragmented.

5.7 Conclusion

We tested the full insurance hypothesis by checking consumption responses to income changes in the context of the Chinese economy. The main findings are as follows:

(a) We reject the full insurance hypothesis in the context of the Chinese economy when we use income change as the idiosyncratic shock variable, particularly in rural areas (however with a very low coefficient). Our study shows that informal institutional arrangements do part of the work of protecting rural households against income change. Meanwhile, we cannot reject full insurance in urban areas (recall the institutional background of China.) This tells us that social security and different kinds of income support programs for urban people do insure households from income shocks. Although these systems were established under the planned economy they are now criticised by most economists and policy makers for their inefficiency and financial fragility[25].

(b) Full insurance within the village cannot be rejected. At present, informal institutional arrangements are doing a good job at village level. The informal credit market probably plays an important role in providing consumption insurance. Knowledge of traditional village life in China helps to explain this full insurance phenomenon. Because information and enforcement problems can be coped with within the village setting, the informal market will work well. Of course this explanation needs an explicit model to formalise it.

(c) We completely reject full insurance in the context of regression for sample villages. There is no full insurance across villages. This confirms the explanation above. Factors such as long periods of living together and accessibility to information about ability, output, effort of village members and the village legal system can work to overcome the difficulties raised by moral hazard, adverse selection etc. within the village. However, these information networks may lose their function across villages. For these reasons, we can observe that there is full insurance within villages, but not across.

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[25] In this chapter we use income change as idiosyncratic risk. The potential mismeasurement of income will down bias our estimate. So if the measurement errors are quite big, we could not reject the hypothesis of full consumption insurance. So we need to be cautious to interpret our results. We could not reject full consumption insurance for urban areas and within village. This may come from poor measurement of the income. To overcome this problem, we use illness shock in Chapter 6 to examine the full consumption insurance hypothesis.

It thus seems that China needs to establish a social security system and income support system in rural areas as soon as possible. Of course, the biggest problem is to decide if the insurance system should be government oriented or market oriented. It is beyond the scope of this chapter to discuss this argument further.

Table 5.2: The Definitions of the Variables

Name	Definition
cg8991	Food consumption growth rate of the household from 1989 to 1991.
grai8991	Grain consumption growth rate from 1989 to 1991
ngra8991	Non-grain consumption growth rate from 1989 to 1991
incg8991	Income growth rate from 1989 to 1991.
size8991	Household size growth rate from 1989 to 1991.
liaoning	Province dummy
jiangsu	Province dummy
shandong	Province dummy
henan	Province dummy
hubei	Province dummy
hunan	Province dummy
guangxi	Province dummy
cgv	Growth rate of village consumption
incgv	Growth rate of village income
sizegv	Population growth of village

Table 5.3: The Statistical Description of Main Variables

Variable	Definition	Mean	Std. Dev.
grain93	Grain consumption in 93	6.73	4.58
foode93	Food in 93	12.95	7.06
grain91	Grain in 93	7.15	4.47
foode91	Food in 91	13.38	6.83
grain89	Grain in 89	7.62	4.92
foode89	Food in 89	13.96	8.12
ngrain93	Non-grain in 93	6.22	4.82
ngrain91	Non-grain consumption in 91	6.23	4.71
ngrain89	Non-grain consumption in 89	6.34	5.72
incto89	Income of 89	3235	4275
incto91	Income of 91	3025	3827
incto93	Income of 93	3700	7198
size91	Household size in 91	4.09	1.45

Table 5.4.1: Regression of Food Consumption Growth Rate against Income Change

	Total sample		Rural areas		Urban areas	
cg8991	Coef.	t	Coef.	t	Coef.	t
incg8991	0.023	2.75	0.024	2.46	0.017	1.02
size8991	0.726	16.43	0.741	13.81	0.709	9.05
agehead	-0.001	-1.43	0.000	-0.01	-0.004	-2.43
agewife	0.000	0.64	0.000	0.04	0.001	0.60
liao	0.214	5.40	0.208	4.53	0.248	3.19
jiangsu	0.045	1.17	-0.003	-0.06	0.155	2.10
shandong	0.132	3.38	0.146	3.26	0.100	1.28
henan	0.039	0.98	-0.001	-0.03	0.124	1.64
hubei	0.032	0.85	-0.032	-0.72	0.179	2.41
hunan	0.184	4.76	0.178	3.98	0.192	2.53
guangxi	0.036	0.93	0.033	0.74	0.067	0.87
_cons	-0.043	-0.92	-0.068	-1.22	0.033	0.35
R sq	0.112		0.1193		0.117	
N	3028		2089		939	

Table 5.4.2: Regression of Grain Consumption Change against Income Change

	Total sample		Rural areas		Urban areas	
grai8991	Coef.	t	Coef.	t	Coef.	t
incg8991	0.018	2.13	0.013	1.30	0.030	1.80
size8991	0.789	17.15	0.797	14.09	0.786	10.01
agehead	-0.004	-4.59	-0.003	-2.41	-0.005	-3.38
agewife	0.000	0.23	0.001	0.63	0.000	-0.41
liao	0.227	5.54	0.251	5.17	0.219	2.84
jiangsu	0.038	0.95	-0.057	-1.20	0.258	3.49
shandong	0.040	0.99	0.092	1.96	-0.078	-1.00
henan	0.037	0.90	-0.016	-0.34	0.161	2.13
hubei	-0.049	-1.25	-0.055	-1.17	0.002	0.02
hunan	0.061	1.53	0.040	0.84	0.128	1.69
guangxi	-0.061	-1.52	-0.082	-1.74	0.001	0.01
_cons	0.118	2.46	0.076	1.29	0.106	1.14
R sq	0.134		0.135		0.161	
N	3013		2081		932	

Table 5.4.3: Regression of Non-grain Consumption Change against Income Change

	Total sample		Rural areas		Urban areas	
ngra8991	Coef.	t	Coef.	t	Coef.	t
incg8991	0.038	2.96	0.047	3.06	0.007	0.28
size8991	0.691	10.20	0.712	8.41	0.666	5.89
agehead	0.001	0.82	0.002	1.08	-0.002	-1.13
agewife	0.000	0.30	-0.001	-0.73	0.002	1.04
liao	0.204	3.37	0.181	2.50	0.236	2.11
jiangsu	0.114	1.93	0.125	1.76	0.073	0.69
shandong	0.206	3.43	0.195	2.75	0.220	1.95
henan	0.051	0.84	0.030	0.41	0.070	0.64
hubei	0.083	1.41	0.009	0.12	0.201	1.88
hunan	0.330	5.59	0.354	5.04	0.235	2.15
guangxi	0.231	3.87	0.264	3.72	0.178	1.61
_cons	-0.191	-2.70	-0.201	-2.30	0.009	0.07
R sq	0.052		0.058		0.053	
N	3026		2087		939	

Table 5.5.1: Regression of Consumption Change against Income Change [Village (neighbourhood) Consumption Change Included]

	Total sample		Rural areas		Urban areas	
cg8991	Coef.	t	Coef.	t	Coef.	t
cgv	0.932	22.07	0.948	18.81	0.900	10.1
incg8991	0.007	0.85	0.007	0.76	0.006	0.36
size8991	0.655	15.92	0.670	13.48	0.632	8.5
agehead	-0.001	-1.50	-0.001	-1.02	-0.001	-1.3
agewife	0.001	1.60	0.001	1.20	0.000	1.1
liao	-0.008	-0.21	-0.017	-0.38	0.014	0.2
jiangsu	-0.004	-0.12	-0.009	-0.22	0.008	0.11
shandong	-0.011	-0.29	0.001	0.02	-0.040	-0.55
henan	0.021	0.58	0.033	0.77	0.000	0.008
hubei	-0.003	-0.07	0.001	0.02	-0.002	-0.04
hunan	0.013	0.37	0.012	0.28	0.012	0.17
guangxi	0.040	1.11	0.040	0.97	0.040	0.6
_cons	0.031	0.71	0.022	0.43	0.069	0.8
R sq	0.236		0.248		0.120	
N	3028		2089		939	

Table 5.5.2: Regression of Grain Consumption Change against Income [Village (neighbourhood) Consumption Change Included]

	Total sample		Rural areas		Urban areas	
grai8991	Coef.	t	Coef.	t		
gr8991	0.933	23.84	0.952	19.74	0.870	11.4
incg8991	0.012	1.47	0.007	0.73	0.023	1.47
size8991	0.719	17.01	0.708	13.58	0.740	10.1
agehead	-0.002	-2.14	-0.002	-1.95	-0.001	-0.34
agewife	0.001	0.82	0.001	1.10	0.000	0.002
liao	-0.014	-0.35	-0.021	-0.45	0.001	0.021
jiangsu	-0.007	-0.19	-0.014	-0.33	0.016	0.22
shandong	-0.016	-0.42	-0.003	-0.07	-0.050	-0.08
henan	0.017	0.45	0.023	0.51	0.005	-0.07
hubei	-0.018	-0.49	-0.009	-0.22	-0.037	-0.55
hunan	0.002	0.06	0.004	0.09	0.000	-0.003
guangxi	0.028	0.76	0.026	0.60	0.020	0.37
_cons	0.084	1.91	0.079	1.48	0.110	1.36
R sq	0.272		0.272		0.260	
N	3013		2081		932	

Table 5.5.3: Regression of Non-grain Consumption Change against Income [Village (neighbourhood) Consumption Change Included]

	Total sample		Rural areas		Urban areas	
ngra8991	Coef.	t	Coef.	t		
ngr8991	0.955	24.02	0.955	19.78	0.950	12.6
incg8991	0.001	0.11	0.009	0.60	-0.017	-0.8
size8991	0.627	10.09	0.666	8.57	0.560	5.4
agehead	0.000	-0.40	0.000	-0.08	-0.001	-0.54
agewife	0.001	1.45	0.001	0.53	0.002	1.59
liao	-0.010	-0.19	-0.025	-0.38	0.020	0.18
jiangsu	-0.012	-0.22	-0.017	-0.25	0.000	0.008
shandong	-0.006	-0.11	-0.003	-0.05	-0.008	-0.08
henan	0.024	0.44	0.038	0.56	0.005	0.06
hubei	0.009	0.17	0.008	0.13	0.010	0.1
hunan	0.018	0.32	0.014	0.21	0.022	0.22
guangxi	0.057	1.03	0.060	0.91	0.064	0.63
_cons	-0.023	-0.35	-0.013	-0.16	-0.023	-0.186
R sq	0.204		0.207		0.180	
N	3026		2087		939	

Table 5.6.1: Regression of Consumption Change of Village or Neighbourhood against Its Income Change

	Food growth		Grain growth		Non-grain growth	
cgv	Coef.	t	Coef.	t	Coef.	t
incgv	0.108	4.13	0.084	2.83	0.165	3.99
_cons	-0.026	-1.57	-0.057	-3.07	-0.002	-0.07
R sq	0.084		0.041		0.079	
N	188		188		188	

Table 5.6.2: Regression of Consumption Change of Village or Neighbourhood Against Its Income Change (Controlling Population Change)

	Food growth		Grain growth		Non-grain growth	
cgv	Coef.	t	Coef.	t	Coef.	t
incgv	0.087	3.46	0.061	2.13	0.146	3.55
sizegv	1.200	4.90	1.286	4.62	1.014	2.52
_cons	0.013	0.76	-0.015	-0.77	0.031	1.08
R sq	0.190		0.140		0.109	
N	188		188		188	

Table 5.6.3: Regression of Consumption Change of Village or Neighbourhood against Its Income Change (Controlling Population Change and Regional Dummies)

	Food growth		Grain growth		Non-grain growth	
cgv	Coef.	t	Coef.	t	Coef.	t
incgv	0.079	2.90	0.021	0.68	0.196	4.34
sizegv	1.148	4.72	1.136	4.13	1.138	2.84
liaoning	0.115	1.71	0.300	3.95	-0.179	-1.62
jiangsu	-0.015	-0.24	0.103	1.45	-0.161	-1.57
shandong	0.071	1.15	0.125	1.78	-0.113	-1.10
henan	-0.015	-0.25	0.100	1.48	-0.226	-2.29
hubei	-0.039	-0.62	0.035	0.49	-0.268	-2.59
hunan	0.120	1.97	0.131	1.91	0.039	0.39
guizhou	-0.066	-1.06	0.057	0.80	-0.302	-2.93
_cons	-0.009	-0.20	-0.126	-2.37	0.187	2.42
R sq	0.270		0.236		0.199	
N	188		188		188	

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5.9 Appendix

Table A5.1: Regression of Growth of Consumption against Income Change (Panel Data of 1989, 1991 and 1993)

cg	Coef.	t	Coef.	t	Coef.	t
incg	0.017	2.85	0.02	3.043	0.006	0.45
size8993	0.695	22.72	0.74	19.681	0.630	11.73
liao	0.121	4.30	0.13	3.840	0.115	2.10
jiangsu	0.033	1.20	0.00	0.140	0.096	1.83
shandong	0.109	3.89	0.10	3.164	0.133	2.32
henan	0.006	0.21	0.00	0.048	0.026	0.47
hubei	0.021	0.78	-0.01	-0.462	0.098	1.87
hunan	0.077	2.81	0.07	2.300	0.093	1.74
guangxi	0.006	0.23	0.01	0.224	0.011	0.21
_cons	-0.054	-2.84	-0.05	-2.109	-0.078	-2.00
R sq	0.094		0.10		0.082	
N	5781		3975		1806	

Table A5.2: Regression of Food Consumption Growth against Income Change with Control of the Aggregate Food Consumption in Village or Neighbourhood (1989,1991 and 1993)

	Total sample		Rural areas		Urban areas	
cg	Coef.	t	Coef.	t	Coef.	t
incg	0.007	1.22	0.007	1.16	0.004	0.33
cgv	0.939	30.16	0.948	25.65	0.923	15.82
size8993	0.639	22.42	0.684	19.64	0.572	11.35
liao	0.002	0.09	-0.004	-0.12	0.013	0.26
jiangsu	0.002	0.08	-0.005	-0.17	0.016	0.31
shandong	0.003	0.12	0.004	0.15	0.001	0.02
henan	0.010	0.36	0.020	0.65	-0.007	-0.14
hubei	0.006	0.23	-0.005	-0.19	0.027	0.56
hunan	0.007	0.28	0.010	0.32	0.004	0.07
guangxi	0.019	0.76	0.007	0.24	0.047	0.92
_cons	0.012	0.67	0.011	0.57	0.012	0.31
R sq	0.217		0.231		0.194	
N	5781		3975		1806	

Table A5.3.1: Regression of Consumption Change of Village or Neighbourhood against Its Income Change

	Food growth		Grain growth		Non-grain growth	
cgv	Coef.	t	Coef.	t	Coef.	t
incgv	0.057	3.22	0.045	2.22	0.090	3.41
_cons	-0.036	-3.15	-0.066	-5.17	-0.003	-0.19
R sq	0.027		0.013		0.030	
N	376		376		376	

Table A5.3.2: Regression of Consumption Change of Village or Neighbourhood Against Its Income Change (Controlling Population Change)

	Food growth		Grain growth		Non-grain growth	
	Coef.	t	Coef.	t	Coef.	t
incgv	0.047	2.74	0.034	1.73	0.080	3.06
sizegv	1.061	6.06	1.127	5.64	1.062	3.95
_cons	-0.004	-0.32	-0.033	-2.38	0.029	1.55
R sq	0.114		0.091		0.069	
N	376		376		376	

Table A5.3.3: Regression of Consumption Change of Village or Neighbourhood against Its Income Change (Controlling Population Change, Year and Regional Dummies)

	Food growth		Grain growth		Non-grain growth	
cgv	Coef.	t	Coef.	t	Coef.	t
incgv	0.050	2.91	0.037	1.88	0.081	3.04
sizegv	1.070	6.11	1.136	5.68	1.064	3.95
year93	-0.025	-1.16	-0.025	-1.00	-0.007	-0.21
_cons	0.009	0.54	-0.020	-1.11	0.032	1.29
R sq	0.117		0.093		0.069	
N	376		376		376	

Chapter 6

Consumption Insurance against Illness Shocks in China

6.1 Introduction

This chapter continues to test the full consumption insurance hypothesis in China. We test if the change of consumption response to major illness shocks that reflect the substantial risks facing consumers. The reasons for examining the response of consumers to illness shock are as follows:

Firstly, in developing countries such as China, many workers are left exposed to risks. Illness shock may be the most significant and least predictable shock to future opportunities of consumers. Illness usually brings huge medical expenditure and a direct reduction of income. In China, the process of making the transition from a planned economy to a market oriented economy has resulted in the collapse of the collective system. The commune system has been replaced by the Family Responsibility System and farm land has been equally distributed to each family. The collective medical insurance system, established under the planned economy, has also been destroyed as a result of the quasi-privatisation movement in rural areas. Without any formal medical insurance system, can Chinese rural people succeed in protecting their consumption against illness shock?

The answer to this question has significant policy implications with regards to recent moves to reform the Chinese social security system. At present, the Chinese government seems to believe that informal institutional arrangements function well-enough in rural areas to insure consumers against a variety of risks. Because the government also lacks administration skills and resources, very little effort has been made to establish a medical insurance system covering rural residents in the recent wave of reforms to the social security system. Increasingly, observers are finding that many families are falling into poverty because they are unable to deal with the risks brought on by income shocks such as illness. We believe that Chinese policy makers, who are reconsidering social security system reform strategies, would benefit from careful examination of how, and to what extent, consumers are able to insure themselves against illness shock.

Secondly, in previous research undertaken by Mace (1991), Townsend (1994) and Jalan and Ravallion (1999), income shocks were carefully examined. The basic weakness of these tests relates to the attenuation effect of measurement error of the income variable. In this case, the extent of consumption smoothing is very likely to be overestimated. Cochrane (1991) included some variables such as number of illness days and rejected the full insurance hypothesis for the US economy. It is believed that variables such as illness status may be measured in a more precise way than by using income. If we examine the response of consumers to illness shock, we may get a more precise estimation of consumption smoothing.

Thirdly, special institutional arrangements in China allow us to understand the efficacy of existing medical insurance. It is almost impossible for Chinese rural residents to access any formal medical insurance services. At the same time, urban residents are covered by medical care provided by either government or state owned enterprise. If the only consequence of illness is medical care expenditure, we are expected to observe that urban residents are able to fully insure against illness shock, since their medical care costs are covered. In contrast, if illness also dramatically reduces consumer income, both urban and rural residents may not be able to smooth consumption.

Testing the extent to which household consumption responds to the risk of income change due to illness is important for the future course of economic reform in China. If the loss to welfare bought on by incomplete insurance is very large, natural logic dictates that future reform should shift emphasis from privatisation and decentralisation to the establishment of a national social security system.

In this study, we use very detailed variables to measure illness shock. Illness variables in our data describe four kinds of illness: conditions related the heart, lungs and stomach; conditions of the upper extremities, shoulders, neck and upper back; conditions of the lower extremities and spinal cord; and conditions related to hearing, eyesight and speech. The results show that consumers with medical insurance can insure very well against illness shock. However, consumers in rural areas (most of them without medical insurance) are able to smooth their consumption against short-term illness shock, but they fail to do this in the face of long-term illness shock. The results show that household consumption is reduced by over 20% when the head of the household has been ill for a period of two years.

This chapter is organised as follows. Section 6.2 is a short literature review. We discuss the institutional setting during the transition period in China and relevant aspects of illness shock in section 6.3. Section 6.4 describes the data and our empirical results. Section 6.5 presents a short conclusion.

6.2 Literature Review

We reviewed the related literature in Chapter 5 and found that empirical findings from previous works were mixed on the question of the availability of full consumption insurance both for developed countries (Cochrane 1991; Mace 1991; Attanasio and Davis 1996; Nayga, Tepper et al. 1999) and for developing countries (Townsend 1994; Lim and Townsend 1998; Gertler and Gruber 2002).

This study, in the context of developing countries, is of special interest. People facing substantial illness risks in low level income countries are more likely to fail in smoothing consumption against various shocks. Failure to adjust consumption not only drops these families into a temporary state of poverty, but also permanently destroys the health of family members and reduces their future possibility of success. This is particularly true in the case of women and children. The link between health and labour market outcomes has been well established by development economists Strauss and Thomas (1998). The link between health and productivity makes the cost of failure to shield consumption from illness shocks, in low-income countries, much more serious than it first appears.

In recent years, empirical research on insurance has been divided into two streams. One focuses on gathering more detailed information and attempts to discover how people smooth their consumption in an uncertain world (Dercon and Krishnan 2000).

The other group, inspired by Morduch (1995) argues that the ability of people to smooth their consumption is not precisely measured due to the omission of income smoothing. According to Morduch, coping with risk may occur at two stages. First, the household can choose a path of conservative production or employment to protect themselves from adverse income shocks before they occur. Second, households can smooth their consumption by borrowing, savings, depleting and accumulating financial assets, adjusting labour supply, and employing formal and informal insurance arrangements after shocks occur. As a result, any remaining variability in observed income, after the production process has been chosen, may be easily smoothed. In addition, mitigating risk through production choice can be costly because expected profits must be sacrificed for lower risk. This cost can intensify over time as risk-averse households show reluctance in adopting new technologies and taking advantage of new economic opportunities. With these factors in mind, the above-mentioned study may overstate the household's ability to smooth consumption.

In addition to the two stage insurance problem, the measurement error of income variables contaminates the test of full consumption insurance. It is a well-known fact that the attenuation effect of measurement error of right hand side variables, also leads us to overstate the extent of insurance. The strategy used to deal with this problem is to find alternative variables that are less likely to be contaminated by measurement error. We suggest the use of a health shock variable in our study because it may be better measured and reflect the major shock facing consumers (Gertler and Gruber 2002). The striking feature of this kind of variable is its close association with income and expenditure. Gertler and Gruber use this kind of variable to represent shocks facing consumers to overwhelmingly reject the hypotheses of full consumption insurance against periods of illness in Indonesia.

The test of consumption insurance in developing countries attracts attention due to its rich policy implications. In these societies, social security systems such as pensions, unemployment insurance and medical care systems are being established or reformed. How well the existing formal or informal system works has profound implications for newly designed systems.

In this chapter, we will present some evidence about the Chinese family's ability to smooth against shocks arising from a variety of illnesses.

6.3 Institutional Background

Since the communist party came into power in 1949, the Chinese government has demonstrated great concern for the health of the population and energetically sought to develop medical and health care services. A health care network was established in urban and rural areas and a large contingent of professional medical workers trained. China's medical and health care system has been very successful.

In China, medical and health care systems take diverse forms. First, the state provides free medical care service for personnel in public institutions and in government organisations, as well as for students in institutions of higher learning. Second, for free enterprise personnel, a medical care insurance scheme has been adopted whereby expenses are paid wholly by the state through the enterprises. Third, in rural areas, a cooperative medical care system was set up during the period of the planned economy. Funds used to support this medical system were collected from the collectives and the farmers themselves. Patients were treated free of charge or they paid a portion of the medical costs. Those who did not belong to any of these categories were responsible for their own medical expenses. Actually, there were very few people not covered by one of the above pre-reform medical and health systems. In addition, it is worth noting the structure of ownership of medical care institutes. At the end of 1984, 80% of China's hospital beds were owned by the state and 20% were under collective ownership. The funds for support of medical care institutions were allocated from the budgets of government and state owned enterprises.

It is also worth noting that the cooperative medical system in rural areas operated quite differently to medical services in urban areas. In the vast rural area, a three–level medical care network was established. This network centred on medical institutions at the county level that in turn designated public health centres at the township or commune level as local hubs. From the commune level, the network reached out to health clinics at the village or brigade level to form a rural medical care and prevention system. By the end of 1984, there were 2,000 county hospitals, 56,000 township public health centres, and 710,000 village clinics. There were 1.25 million part-time physicians who provided medical services to farmers working in the fields.

The medical care systems established under the planned economy faced many problem after the reform and open-door policy was adopted. The cooperative medical system in rural areas has been almost completely destroyed since the collective production system was abandoned and the family responsibility system introduced at the end of the 1970s. By the end of the 1980s, the majority of the village clinics were contracted by individuals. Farmers were required to pay all of their own medical expenses. In our survey data, only 0.1% of the rural population enjoyed the benefits of the cooperative medical insurance system in 1991.

In this chapter, we will study consumption smoothing against illness and compare the degree of adjustment between people with and without health care insurance. The cost of illness consists of two parts. One is the income foregone and this is associated with reduced labour supply, the other is the cost incurred in diagnosing and treating the illness. It is obvious that the portion of the population that is fully insured by formal medical care insurance only needs to cope with the losses associated with reduced labour supply due to the illness. However, the portion of the population without formal medical care insurance (the majority of whom are rural residents), have to cope with both loss of income due to reduced labour supply and the costs of medical care.

Although families in rural areas are not able to access the formal insurance market, they may rely on informal mechanisms such as dissaving, borrowing and the family network to smooth their consumption against illness. In addition, it seems that labour substitution amongst family members in rural areas is easier than it is in urban areas.

6.4 Specification and Test for Insurance against Illness Shocks

6.4.1 Specifications

This test is based on the full consumption insurance model as in Chapter 1. The full insurance model claims that income risk is spread evenly over the entire population of households through formal or informal insurance mechanisms.

Through solving a planner problem with a constant relative risk aversion utility function and manipulating the first order condition, we can reach the so called full insurance formula which states that individual consumption growth is completely determined by aggregate consumption growth and the preference shifter. Since we implicitly assume that income risk is fully covered by insurance, there is no need for the individual household to adjust its consumption to the realised income once any expansion in community growth has been taken into account.

Therefore we may write our empirical specification to test if families are able to smooth consumption against illness as follows:

$$\log\left(\frac{c_{t+1}^{j}}{c_{t}^{j}}\right) = \alpha + \beta X_{t+1}^{j} + \gamma A_{t}^{j} + \varepsilon_{t+1}^{j} \ . \qquad (6\text{-}1)$$

Where the left-hand side is the consumption growth rate, A_t^j is the demographic term correlated with preference shift, X^j_{t+1} represents the idiosyncratic variable indicating illness.

There are several limitations in previous works that tested full consumption insurance against risks. The measure of health employed was not precise. Information such as "whether the individual got ill or not" has been widely used. Gertler and Gruber (2002) pointed out that this measure might reflect only small changes in health status, not serious unexpected illnesses. Families may be able to insure against small and infrequent illness. To test if families can insure against serious illness has important policy implications. Social planners should use their limited resources to help people to cope with catastrophic illness if families cannot insure themselves from serious illness through informal mechanisms.

Secondly, because of a lack of information, researchers have been unable to distinguish the shocks of various illnesses. Different illnesses will incur different medical cost and will affect labour supply to different degrees.

6.4.2 Data and illness measurement

The data used in this chapter is panel data of the China Health and Nutrition Survey (CHNS). We have taken samples from the 1991 and 1993 data, and dropped the 1989 sample because the measures of health in 1989 are not consistent with that of the later years. We use 2,525 observations with complete information about illnesses.

The key to our analysis is that good measures of health status of family members are available in the CHNS. Good measures of health status need to satisfy two conditions.

One is that the health measure can reflect major illness shock. This means that we need information that will tell us if the illness affects an individual's physical ability to perform the activities of daily living. These measures of physical function allow us to judge if the family is confronted with a large illness shock. The other condition is that the health measure should allow us to understand the problem of state dependence. State dependence refers to consumption change associated with changes in underlying preferences of the household due to illness. The detailed information about symptoms may help us to understand if underlying preferences have been changed.

In the survey, we pose four questions:

(1) "What is the present condition of your heart, your lungs, and stomach?"

(2) "What is the present condition of your upper extremities, shoulders, neck, and upper back?"

(3) "What is the present condition of your lower extremities and spinal cord?"

(4) "What is the present condition of your hearing, eyesight, and speech?"

For each question there are four answers:

(1) "Functioning normally."

(2) "Occasionally affected by work or daily activities."

(3) "Frequently affected by work or daily activities."

(4) "Unable to work or carry out daily activities."

For each kind of illness, we give value one to the illness dummy variable, to indicate the individual choosing answer (3) and (4). This is because individuals who choose answer (3) or (4) face a large illness shock that will incur major costs to them through medical expenditure and reduced labour supply.

Regarding the state dependence problem, the preferences over food consumption may change because of changes in the condition of heart, lungs and stomach. Common knowledge also tells us that changes in the condition of the upper extremities, lower extremities, hearing and speaking may not change preferences over food consumption.

In our test, we define dummies to indicate the health status for the household head in the years 1991 and 1993. For each year, the health of the household head has two states: good or ill. Therefore, in total we have four dummies to indicate these joint health states in 1991 and 1993: (good, good), (good, ill), (ill, good) and (ill, ill).

The description of health status in 1991 and 1993 by areas is presented in Table 6.1 and Table 6.2. There are two features worth noting. The proportion of the population with improved health status (that is from ill to good) is slightly higher than those who reported that his/her health becomes worse (that is from good to ill) (in Table 6.2). This means that average health conditions improved in 1993 compared to 1991. This is consistent with the time trend of the improving health conditions in China attributed to economic development. The other issue is that the proportion of ill people is higher in urban areas than in rural areas (Table 6.1). This should not be true, given that urban residents enjoy higher income levels and better medical insurance. The possible explanation of this is that rural residents systematically overestimate their health conditions compared to their counterparts in urban areas.

6.5 Results

We use estimation equation (5-1) to examine if families can insure against the four kinds of illness shock. We examine each of the illness shocks separately. The assumption is that there exists no correlation between this four illness shocks. There are only 6 observations that report more than two illness symptoms. This justifies our assumption of the independence of the four kinds of illness.

Table 6.3 to Table 6.6 presents the results for the shocks of (1) illness of heart, lung and stomach, (2) illness of upper extremities, shoulder, neck and upper back, (3) illness of lower extremities and spinal cord, (4) illness of hearing, eyesight and speech. For each kind of shock, we report the results for both the sample with formal medical insurance and the sample without it. The family size and regional dummies are controlled.

For the illness of heart, lung and stomach, we cannot reject full insurance for both samples. That is, food consumption does not adjust in response to this illness shock experienced by the family head.

Table 6.4 reports the test of full insurance against illness of upper extremities. The coefficient of the dummy indicating that the household head was ill during both 1991 and 1993 is about 0.19 for the total sample. Consumption does not respond to the other two dummy variables indicating that health becomes better and health becomes worse. This result implies that the family may fail to insure themselves from persistent illness. For farmers in rural areas, another family member may spend extra effort in order to finish the work of the ill member for a short period of time because labour substitution amongst family members is not difficult in traditional farming practice. However, if the family head is ill for a long period of time, the family's income will certainly be seriously reduced because labour substitution amongst family members is imperfect. The informal insurance arrangements may fail to insure this kind of risk.

The results in Table 6.4 show that the consumption growth of households without medical insurance was reduced by about 29 percentage points if the family head was ill in both 1991 and 1993. For the sample with medical insurance, this coefficient is not significant from zero. We cannot reject full insurance for households with medical insurance. This result is not difficult to understand. In the context of China, almost all households with formal medical insurance are in urban areas, except a few people such as government employed primary school and middle-school teachers. The medical costs incurred by households in this sample have been covered substantially by insurance. The important issue here is that physical strength in the urban labour market is not as important as it is in rural areas. Therefore, the illness of upper extremities may not significantly reduce family resources for urban residents.

Table 6.5 presents the estimations for illness of the lower extremities and spinal cord. The results are almost the same as for an illness of the upper extremities. For the sample without medical insurance, the coefficient of the dummy indicating that the household head has been ill for a long period is 0.25. Again, full insurance cannot be rejected for the sample with medical insurance.

The shocks of illness related to hearing, eyesight and speech are examined in Table 6.6. A household head whose condition changes from good to bad condition, will reduce family food consumption growth by 11 percentage points. For the sample with medical insurance, we cannot reject the hypothesis of full consumption insurance. Why doesn't persistent illness of hearing, eyesight and speech reduce consumption? We conjecture that while these illnesses will probably cost a large amount in medical spending, they may not substantially reduce labour supply. Due to the lack of additional information, we cannot explain this point satisfactorily.

We also performed the test exercises by region type: village, city, town and suburban area. However, as mentioned above, almost all of the people in villages are not covered by medical insurance. In contrast to the people in cities and towns are able to access formal medical insurance. We present the results for illness of hearing, eyesight and speech by region types in Table 6.7. Our explanation is that the functions of hearing, eyesight and speech are more important for a worker in the urban labour market than in rural areas. Therefore, a person who lives in an urban area who suffers from an illness related to hearing, eyesight and speech, will reduce his labour supply substantially. In an extreme case, that person may become unemployed. This would reduce his family's resources dramatically if he/she is the primary earner in the family. Table 6.7 shows that food consumption growth was reduced by 24 percentage points due to the illnesses affecting hearing, eyesight and speech for city households lived.

6. 6 Conclusion

In this chapter, we have examined the data to determine if consumers can protect themselves from illness shocks in different institutional settings in China. The measures of health shocks reflect an individual's physical ability to perform daily activities or work. We also use detail symptoms in the study as they may also help to understand if the findings in this chapter are driven by changes in underlying preferences.

Our basic findings are as follows.

(1) The test of full insurance against illness shocks is inconclusive. It appears that households are able to smooth consumption against episodes of short-term illness but not those lasting for long periods. This implies that certain kinds of major illnesses may be difficult to insure against because of large medical costs and reduction of the individual's labour supply.

(2) Amongst the population with formal medical insurance, households are able to shield themselves from illness shocks. This indicates that the medical cost of illness is a large burden for households without medical insurance.

Based on the outcomes of our tests, the policy implications are obvious. Since households without medical insurance are able to insure their consumption against minor illness shocks but not major ones, the optimal for social insurance intervention to adopt should be the extension of insurance coverage to rural areas and that limited resources should be used to insure only catastrophic events. This policy would substantially improve the welfare of households in rural areas and dramatically reduce the new wave of poverty attributable to catastrophic events.

Figure 6.1: Insurance Types

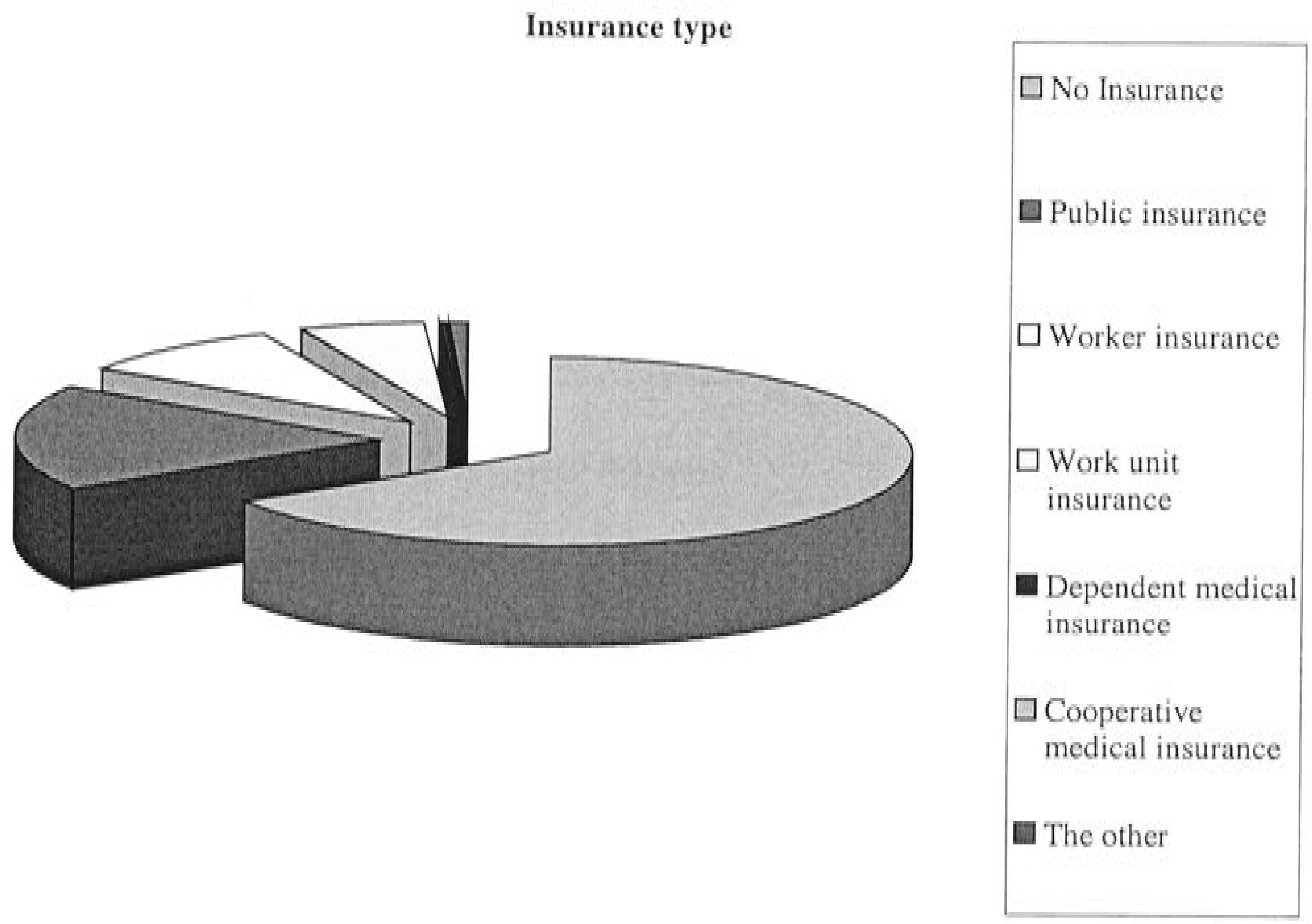

Table 6.1: Description of Present Condition on Health

Present condition on health (total sample)

Variable	Obs	Mean	Std. Dev.	Min	Max
Heart, lung and stomach (1991)	2574	1.096	0.343	1	4
Upper extremity (1991)	2572	1.082	0.342	1	4
Lower extremity(1991)	2572	1.070	0.293	1	4
Sensory function (1991)	2570	1.095	0.353	1	4
Heart, lung and stomach (1993)	2574	1.101	0.364	1	4
Upper extremity (1993)	2572	1.070	0.308	1	4
Lower extremity(1993)	2572	1.077	0.291	1	4
Sensory function (1993)	2570	1.099	0.347	1	4

Present Condition on Health (Rural Areas)

Variable	Obs	Mean	Std. Dev.	Min	Max
Heart, lung and stomach (1991)	1723	1.081	0.321	1	4
Upper extremity (1991)	1722	1.057	0.293	1	4
Lower extremity(1991)	1722	1.055	0.252	1	4
Sensory function (1991)	1722	1.072	0.312	1	4
Heart, lung and stomach (1993)	1723	1.095	0.354	1	4
Upper extremity (1993)	1723	1.048	0.245	1	3
Lower extremity(1993)	1722	1.057	0.234	1	3
Sensory function (1993)	1721	1.063	0.278	1	3

Present Condition on Health (Urban Areas)

Variable	Obs	Mean	Std. Dev.	Min	Max
Heart, lung and stomach (1991)	807	1.121	0.370	1	3
Upper extremity (1991)	806	1.130	0.413	1	4
Lower extremity(1991)	806	1.103	0.364	1	4
Sensory function (1991)	804	1.144	0.425	1	4
Heart, lung and stomach (1993)	807	1.116	0.391	1	4
Upper extremity (1993)	805	1.111	0.401	1	4
Lower extremity(1993)	806	1.122	0.383	1	4
Sensory function (1993)	805	1.171	0.447	1	4

Note: There are 44 households whose information about living in rural or urban is missing.

Table 6.2: Dummy Variables for Change of Health Status

	Total sample		Rural area		Urban area	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
heart11	0.86	0.35	0.88	0.33	0.83	0.37
heart12	0.06	0.23	0.05	0.21	0.07	0.26
heart21	0.06	0.24	0.06	0.23	0.06	0.24
heart22	0.02	0.15	0.02	0.14	0.03	0.18
upextr11	0.89	0.31	0.92	0.27	0.83	0.38
upextr12	0.05	0.22	0.04	0.19	0.08	0.28
upextr21	0.05	0.21	0.03	0.18	0.07	0.25
upextr22	0.01	0.11	0.01	0.08	0.02	0.15
loextr11	0.89	0.32	0.90	0.29	0.85	0.36
loextr12	0.04	0.20	0.04	0.19	0.05	0.22
loextr21	0.05	0.22	0.05	0.21	0.07	0.25
loextr22	0.02	0.14	0.01	0.11	0.04	0.19
sensor11	0.86	0.34	0.90	0.29	0.78	0.41
sensor12	0.05	0.22	0.04	0.20	0.07	0.26
sensor21	0.06	0.23	0.04	0.19	0.10	0.30
sensor22	0.03	0.16	0.02	0.13	0.05	0.22

Note: "...11" is a dummy for the household head's health status is good in both 1991 and 1993
"...12" is a dummy for the household head's health is good in 1991 but got problem in 1993.
"...21" is a dummy for the household head's health has problem in 1991 but good in 1993.
"...22" is a dummy for the household head's health has problem in both 1991 and 1993.

Table 6.3: Regression of Illness Shocks (Health Status of Heart, Lungs and Stomach)

	Total sample		Sample without medical insurance		Sample with medical insurance	
	Coef.	t	Coef.	t	Coef.	t
heart12	-0.005	-0.12	-0.054	-0.95	0.090	1.174
heart21	0.008	0.17	0.020	0.36	-0.014	-0.198
heart22	-0.013	-0.19	-0.054	-0.56	0.015	0.160
size9193	0.671	14.65	0.689	12.09	0.620	7.801
liaoning	0.003	0.09	0.032	0.60	-0.019	-0.249
jiangsu	0.004	0.11	0.056	1.01	-0.017	-0.244
shandong	0.113	2.75	0.093	1.94	0.187	2.243
henan	-0.054	-1.24	-0.039	-0.80	-0.076	-0.805
hubei	-0.030	-0.75	0.007	0.14	-0.082	-1.054
hunan	-0.027	-0.69	-0.034	-0.76	0.017	0.208
guangxi	0.004	0.10	0.026	0.59	-0.042	-0.494
_cons	-0.014	-0.49	-0.018	-0.58	-0.021	-0.343
R sq	0.086		0.090		0.087	
N	2525		1659		856	

Table 6.4: Regression of Illness Shock (Upper Extremities Illness) by Insurance Type

	Total sample		Sample without medical insurance		Sample with medical insurance	
	Coef.	t	Coef.	t	Coef.	t
upextr12	0.026	0.55	0.035	0.56	0.021	0.29
upextr21	-0.023	-0.46	-0.017	-0.23	-0.020	-0.29
upextr22	-0.194	-2.04	-0.291	-2.16	-0.101	-0.74
size9193	0.673	14.72	0.697	12.23	0.615	7.73
liaoning	0.008	0.19	0.038	0.71	-0.016	-0.21
jiangsu	0.008	0.21	0.055	1.00	-0.015	-0.21
shandong	0.114	2.78	0.093	1.94	0.184	2.22
henan	-0.052	-1.20	-0.038	-0.77	-0.079	-0.84
hubei	-0.029	-0.73	0.006	0.13	-0.083	-1.07
hunan	-0.026	-0.65	-0.034	-0.75	0.017	0.20
guangxi	0.007	0.19	0.026	0.59	-0.042	-0.50
_cons	-0.014	-0.50	-0.020	-0.63	-0.016	-0.25
R sq	0.088		0.092		0.087	
N	2525		1659		856	

Table 6.5: Regression of Illness Shock (Lower Extremities Illness) by Insurance Type

	Total sample		Sample without medical insurance		Sample with medical insurance	
cg9193	Coef.	t	Coef.	t	Coef.	t
loextr12	-0.023	-0.44	-0.049	-0.76	0.014	0.16
loextr21	0.011	0.23	-0.029	-0.50	0.086	1.12
loextr22	-0.214	-2.88	-0.247	-2.36	-0.174	-1.64
size9193	0.670	14.67	0.692	12.16	0.615	7.77
liaoning	0.008	0.20	0.037	0.70	-0.014	-0.19
jiangsu	0.008	0.21	0.057	1.03	-0.018	-0.25
shandong	0.112	2.73	0.089	1.86	0.181	2.18
henan	-0.046	-1.05	-0.032	-0.65	-0.069	-0.73
hubei	-0.031	-0.77	0.003	0.07	-0.084	-1.07
hunan	-0.026	-0.67	-0.036	-0.79	0.020	0.24
guangxi	0.007	0.19	0.028	0.62	-0.035	-0.41
_cons	-0.011	-0.41	-0.014	-0.46	-0.019	-0.30
R sq	0.089		0.093		0.090	
N	2525		1659		856	

Table 6.6: Regression of Illness Shock (Sensory Illness) by Insurance Types

cg9193	Total sample		Sample without medical insurance		Sample with medical insurance	
	Coef.	t	Coef.	t	Coef	t
sensor12	-0.118	-2.51	-0.112	-1.91	-0.123	-1.53
sensor21	-0.057	-1.27	-0.086	-1.27	-0.018	-0.29
sensor22	-0.064	-1.03	-0.056	-0.60	-0.064	-0.76
size9193	0.665	14.56	0.688	12.08	0.607	7.65
liaoning	0.007	0.16	0.029	0.55	-0.015	-0.20
jiangsu	0.007	0.18	0.052	0.94	-0.021	-0.29
shandong	0.113	2.77	0.094	1.95	0.178	2.14
henan	-0.042	-0.97	-0.031	-0.64	-0.064	-0.67
hubei	-0.031	-0.78	0.002	0.04	-0.085	-1.09
hunan	-0.030	-0.77	-0.039	-0.85	0.007	0.09
guangxi	0.004	0.11	0.024	0.53	-0.048	-0.57
_cons	-0.004	-0.16	-0.010	-0.32	-0.004	-0.06
R sq	0.089		0.092		0.089	
N	2525		1659		856	

Table 6.7: Regression of Illness Shock (Sensory Illness) by Region Types

cg9193	Village		Village(and without medical insurance)		City		Town		Suburban	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
sensor12	-0.088	-1.32	*-0.137*	*-1.90*	*-0.237*	*-2.50*	-0.096	-0.81	0.083	0.48
sensor21	-0.067	-0.85	-0.058	-0.69	-0.089	-0.97	-0.034	-0.38	-0.011	-0.08
sensor22	-0.120	-1.15	-0.123	-1.01	-0.093	-0.83	0.066	0.50	-0.089	-0.41
size9193	0.646	10.08	0.620	9.06	0.416	4.01	0.901	8.01	0.854	6.18
liaoning	0.015	0.26	0.036	0.60	0.032	0.30	-0.262	-2.29	0.094	0.99
jiangsu	0.004	0.07	0.068	1.10	0.127	1.17	-0.180	-1.84	0.039	0.34
shandong	0.173	3.09	0.170	2.94	0.275	2.34	-0.132	-1.32	0.019	0.19
henan	-0.034	-0.59	-0.027	-0.45	-0.089	-0.76	-0.019	-0.18	-0.115	-0.97
hubei	-0.012	-0.22	0.004	0.07	-0.018	-0.16	-0.108	-1.05	-0.065	-0.66
hunan	-0.020	-0.37	-0.026	-0.47	-0.078	-0.72	-0.074	-0.74	-0.031	-0.33
guangxi	0.056	1.06	0.061	1.12	-0.085	-0.76	-0.155	-1.56	-0.008	-0.09
_cons	-0.027	-0.74	-0.028	-0.73	-0.034	-0.42	0.135	1.83	0.004	0.05
R sq	0.091		0.087		0.101		0.155		0.100	
N	1295		1148		403		402		425	

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Chapter 7

How Prudent Are Community Representative Consumers?

7.1. Introduction

Many recent studies have investigated the role of precautionary savings in the life-cycle consumption model. While theoretical analysis has devoted considerable attention to the precautionary savings motive since the pioneering work done by Sandmo (1970) and Dreze and Modigliani (1972), the empirical importance of these studies is still an open question. Carroll (1994), Carroll and Samwick (1997, 1998), and Lusardi (1997, 1998) present evidence of a significant level of precautionary motivation whereas other studies have found little or no evidence of precautionary savings (Kuehlwein 1991; Dynan 1993; Starr-McCluer 1996).

Among empirical studies that have directly tested the role of precautionary savings, Dynan (1993) was able to directly estimate a relative prudence coefficient (a parameter in the utility function) that reflects the strength of the precautionary savings motive. Using consumption variance to capture all forms of risk, Dynan found that the prudence coefficient implied from the estimation was too small to be consistent with widely accepted beliefs about risk aversion (Mehra and Prescott 1985).

An extremely small estimate of prudence coefficient may result if individual households are not cut off from all forms of insurance opportunities. A key assumption in the standard life-cycle-permanent-income model, employed by Dynan, is that some individuals are not able to access insurance markets and almost all assets markets. This model assumes that individual households can only purchase non-negative amounts of single, risk-free assets. Therefore, the absence of insurance markets causes them to adjust their holdings by seeking "self-insurance". However, if individual households were able to purchase insurance or share risks among themselves through informal arrangements, their consumption would be less sensitive to idiosyncratic risks than if they could not insure at all. In the extreme case of full insurance, household consumption will only respond to aggregate risks. As a result, the relative prudence coefficient cannot be identified using data based on individual households.

The weak result for precautionary motives may also stem from measurement error. Cogley (2002) argues that 98% of the variance in individual consumption growth in the USA can be attributed to measurement error. Measurement error biases the estimate down to zero. Furthermore, the short time period in the dataset used by Dynan makes the key coefficient biased unless we unrealistically assume that there are complete markets between cross-sectional units (Altug and Miller 1990; Deaton 1992).

In this paper, we have used a unique dataset of Chinese household consumption to estimate the relative prudence coefficient of a representative consumer in the community. Our focus on the community, rather than individual households, is motivated by two salient features of Chinese communities:[26] (1) they are largely isolated from each other; and (2) a significant amount of risk-sharing occurs among households within each community.[27] Dynan's estimation procedure can be justified at the community level in the Chinese context. More importantly, because of risk-sharing behavior within the community, the effective length of the time periods for our estimation is substantially "enlarged": while an average of the forecast errors across N individual households need not converge to zero even when $N \rightarrow \infty$ (Chamberlain 1984), the average of the forecast errors converges to zero as the size of the community goes to infinity under complete risk-sharing within the community. Our empirical results demonstrate that while the growth of household consumption in Chinese communities responds weakly to uncertainty (supported by Dynan's findings), the relative prudence coefficient for a community representative consumer becomes dramatically greater. This is consistent with the widely held belief about the magnitude of risk aversion in the life-cycle consumption model. To check if our results were driven primarily by the simple averaging effect, we conducted an experiment in which we randomly divided households into "fictional communities". We then estimated the prudence coefficient of the representative consumer in the "fictional community". Our results from this experiment indicate that the averaging effect accounts for about one third of the increase in the prudence coefficient.

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[26] In this paper, we refer to Chinese communities as rural villages and urban neighborhoods.
[27] Using the same dataset, Chen (2002) found that the full-consumption insurance hypothesis cannot be rejected within the community, but is overwhelmingly rejected between villages. Townsend (1994) also presents evidence in support of substantial within-village risk-sharing in India.

This paper contributes to the literature in two respects. Firstly, to the best of our knowledge, our study is the first attempt to combine the complete markets model and the precautionary savings model to estimate the relative prudence coefficient at a community level. Averaging across individuals in the same group can reduce measurement error and purely idiosyncratic factors that are not necessarily of interest. Secondly, following Dynan's methodology, we have used variability in food consumption to measure risk. Our data covers three time periods: 1989, 1991 and 1993. This provides a better measure of uncertainty faced by individual households than Dynan's four consecutive quarterly expenditure data.

The rest of the paper is structured as follows. In the next section, we set forth the model and specifications. Section III provides a brief description of consumption insurance in Chinese communities. Section IV describes the data and reports the results. Section V discusses two econometric issues related to the results in Section IV. Section VI concludes.

7.2. The Model and Specifications

Following Dynan's model, we assumed that each household chooses consumption and savings in each period so as to maximize expected lifetime utility, which is time separable. The household's problem at time t can be described as follows:

$$Max\ E_t \sum_{j=0}^{T-t} \left(\frac{1}{1+\delta}\right)^j \left(\frac{C_{i,t+j}^{1-\rho}}{1-\rho}\right)$$

subject to:

$$x_{i,t+1} = (1+r_t)(x_{i,t} - C_{i,t}) + y_{i,t+1}$$

where $C_{i,t}$ is consumption of household i at time t, δ is time preference, $x_{i,t}$ is the asset at time t, $y_{i,t+1}$ represents stochastic labor income of household i at time.

We also assumed a constant relative risk aversion (CRRA) utility function. Hereafter, we ignored the subscript i when it did not cause confusion.

Solving this model and applying a second-order Taylor approximation method, we derived the following specification (see Dynan (1993) for details):

$$\frac{1}{T}\sum_{t=1}^{T} \Delta \log C_{i,t+1} = \alpha_1 + \beta_1 \Big(\frac{1}{T}\sum_{t=1}^{T} (\Delta \log C_{i,t+1})^2\Big) + \varepsilon_{i,t+1} \quad (1)$$

where T represents the number of periods in the sample, $\varepsilon_{i,t+1}$ are error terms , which include two parts: one represents the taste shifter and the other is associated with replacing expected values with their sample means. In this specification, average consumption growth was regressed against average squared consumption growth. The coefficient β_1 equals $\frac{1}{2}(1+\rho)$, and $(1+\rho)$ is the prudence coefficient.

A key assumption of Dynan's model is the absence of insurance markets and almost all asset markets. This implies that all agents are isolated from each other and have to self-insure through savings and dissavings. Browning and Lusardi (1996) argue that the introduction of uncertainty leads to considerable losses in welfare. Thus, there is considerable scope for insurance. Why then do households not use various formal or informal insurance arrangements to insure against income risk, but rely only on self-insurance? If households face idiosyncratic risk, the introduction of some insurance schemes would lead to considerable welfare gain. Browning and Lusardi point out that "the introduction of a precautionary motive leads to a rationale for social insurance and the introduction of the latter leads to a consequent attenuation of the precautionary motive."

The coefficient in equation (7-1) could not be identified if the agents were able to gain access to insurance markets and almost all asset markets. In the extreme case, all individuals would enjoy the same growth rate under complete markets with a CRRA utility function. They would not respond to idiosyncratic risks but to aggregate risks. A cross sectional regression of equation (7-1) would generate a poor estimate because there is insufficient variation in consumption growth across individual households.

Risk-sharing is pervasive both in developed and developing countries. Since the beginning of the 1990s, a line of literature has been growing to test the full insurance hypothesis (Cochrane 1991; Mace 1991; Townsend 1994). The basic idea behind this exploration is that household consumption will not respond to idiosyncratic risk because households can utilize formal or informal insurance markets to share the risk.

It should be noted that Townsend (1994) also suggests the existence of substantial consumption insurance in Indian villages.

In our study, we next tried to combine the standard additive consumption model and full consumption insurance model in order to derive a testable specification. We assumed that there are N households residing in V different communities that are isolated from each other. The number of households in the community v is denoted by v_N. We also assumed that there is a complete market within the community.

Following Cochrane (1991) and Townsend (1994), under some regular conditions, we have

$$\log(\frac{c_{t+1}^j}{c_t^j}) = gc_{v,t}, \quad v = 1,2,..., V; \ j = 1,2,..., v_N$$

(2

where $gc_{v,t} = \frac{1}{v_N}\sum_j^{v_N} \log(\frac{c_{t+1}^j}{c_t^j})$.

Equation (7-2) means that individual consumption growth changes one to one against aggregate community consumption growth $gc_{v,t}$. That is, if the hypothesis of the complete market assumption holds, there exists a representative consumer whose consumption growth is the geometric average of all of the individual households in the community. So combining equation (7-1) and (7-2) yields a new specification as follows:

$$\frac{1}{T}\sum_{t=1}^{T} gc_{v,t} = \alpha_2 + \beta_2(\frac{1}{T}\sum_{t=1}^{T}(gc_{v,t})^2) + e_{v,t+1} \qquad v = 1,2...V$$

(3)

where β_2 is one half the prudence coefficient of the representative consumer in the community.

We then tested specification (1) and (3) and compared the two results in the next section. Both specifications examine the relationship between consumption growth and uncertainty in consumption, not in income. Since in either specification the taste shifter in error terms is likely to be correlated with average squared consumption growth, instrumental variables are needed to obtain a consistent estimate of β_1 and β_2. In this instance, we employed commonly used instrumental variables, such as occupation, education, regions and the number of adults in the household.

Casual observations reveal that households in Chinese communities that are virtually confined to remaining in one location are able to insure against risks among themselves through formal and informal arrangements. Chapter 5 demonstrates that there is some evidence of the presence of within-community consumption insurance in China. Under these circumstances, the estimated coefficient β_2 in specification (3) should be greater than β_1 in specification (1). This is because the latter measures the strength of the representative consumer's response to uninsured, community-wide aggregate risk, while the former measures the individual household's response in consumption to both insured (idiosyncratic) and uninsured (aggregate) risk.

Estimating specification (7-3) using community level data reflects the need to take into account within-community insurance and has the advantage of reducing measurement errors associated with individual consumption variations. Cogley (2002) found that 98% of the variance in individual consumption growth in the USA arises from measurement errors. The weak result in Dynan's test may suffer from serious measurement errors that contribute to the variation in consumption growth among the individuals.

The problem of short time periods has long perplexed the empirical studies of consumption behavior in general and those of precautionary savings in particular (Altug and Miller 1990; Deaton 1996; Attanasio and Weber 1995). A well-cited remark made by Chamberlain (1984: 1311) points out the critical difference between cross section moments and time-series moments. The short time period makes the coefficient estimate in life-cycle model biased unless we make a very unrealistic assumption about the presence of complete markets between cross sectional units.

Our estimation based on the community level, to some extent, may help us reduce the seriousness of the short panel problem.[28] Based on specification (7-3), it can be shown that if there is complete risk-sharing within the community but not between communities, the average of forecast errors converges to zero as the size of the

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[28] We are very grateful to Per Krusell for directing us to exploring this possibility explicitly.

community goes to infinity. Let us imagine one community which contains, say, 20 households. If there is one observation on the community at one time point, it is virtually equivalent to observing the typical household 20 times over time under complete risk-sharing regime. Consequently, averaging all the individual households within the community helps "enlarge" the effective length of time period in our analysis.

7.3. Consumption Insurance in Chinese Communities

In China, the community, rural village or urban neighborhood, are not formal layers of government administration. People who live in a rural village usually share the same ancestors, and consequently, the village is dominated by one major surname. The villagers not only live together, but they collectively own some productive resources, such as land. In contrast, residents in urban neighborhoods may come from diverse sources and as a group are not as homogenous as villagers. However, as a result of the long period of China's planned economy, state-owned work units provided concentrated housing for their workers. In many urban neighborhoods, a majority of the residents are associated with one or two work units. In the areas sampled in this survey, the average size of a village was about 400 households and 1,973 individuals. The typical urban neighborhood had about 950 households and 3,847 individuals.

It is widely believed that risk-sharing within Chinese communities is pervasive and that formal and informal institutional arrangements help community residents insure each other. These arrangements include: gifts, "loans" from family members, relatives, neighbors and friends, credit groups, production groups, cooperative medical insurance and so forth. These networks considerably attenuate the motivation of precautionary saving.

Apart from these networks, it is difficult for rural residents to obtain insurance beyond the scope of the village due to the lack of formal insurance markets. Across-village contracts are rare because of information asymmetry and high enforcement costs. Insurance plans provided by the government are virtually non-existent for rural areas. In this regard, Chinese villages can be treated as separate "islands". Rural households have to rely on self-insurance to insure against aggregate risks common to the village.

Households in urban neighborhoods also share risks to a substantial degree. This is made possible because of the development of long-term neighborhood relationships resulting from the very low location mobility of urban workers. Even in urban areas, risk-sharing across neighborhoods remains limited for two reasons: (1) until the early 1990s, China's social security plans for workers were mainly work-unit based; and (2) individuals have had limited access to financial markets for consumption loans due to heavy government restrictions.

The standard life-cycle-permanent-income model assumes that consumers are cut off from all insurance markets and almost all assets markets. However, the nature of

Chinese communities, as we describe them above, makes this assumption invalid in the Chinese context if we confine ourselves to the level of individual households. Alternatively, we can reasonably justify approaching the problem at a community level because China's community representative consumers can be approximately treated as "individuals" who are cut off from outside insurance markets.

7.4. Data and Results

The data used in this study was drawn from the three waves of China Health and Nutrition Survey (CHNS) collected in 1989, 1991, and 1993.

The 1989 survey covered 3,795 households and 15,917 individuals. The 1991 and 1993 surveys included 3,616 and 3,441 households respectively. In the construction of the food consumption variable, there were some missing values on food prices and quantities. Some of the information on education levels and occupations of household heads was also incomplete. We therefore had 3,292 effective observations to use in our household-level analysis. We obtained complete information on key characteristics for 170 out of 190 communities surveyed. We deleted 6 villages containing only 3-5 households and used 164 communities for our analysis of consumption behavior at community level. Of this final sample, 80 percent of the communities contained 18-20 households and the remaining communities were made up of 16-18 households.

We constructed food expenditure from information about food consumption and prices charged in the local markets.[29] Food expenditure included consumption of market purchased and self-produced food, valued at market prices. The distribution of consumption growth of both households and communities is shown in Figure 7.1 and Figure 7.2 respectively.

The CHNS also contains several variables that might predict uncertainty and risk confronting individual households. Occupation and education level of the household head, regions, and the number of adults in one household are variables that are widely used as instruments for $avg(gc_i)^2$ (for instance, Dynan 1993; Carroll et al. 1999).

The CHNS contains detailed information of the community and this provided us with the opportunity to estimate equation (7-3) for the representative community consumer. There are some variables in our data set that might predict the representative consumer's risk. These include community population, proportion of the work force in agriculture, access to telecommunications, newspapers, road conditions, and the ownership structure of residential housing. We chose them as good instruments for $avg(gc_v)^2$ in a similar spirit to our choice of instrumental variables (IVs) at household level.

[29] For the details of the data construction, see the Appendix.

Figure 7.1: The Kernel Density Estimate of Average Log Consumption Change of Households ($avg(gc_i)$)

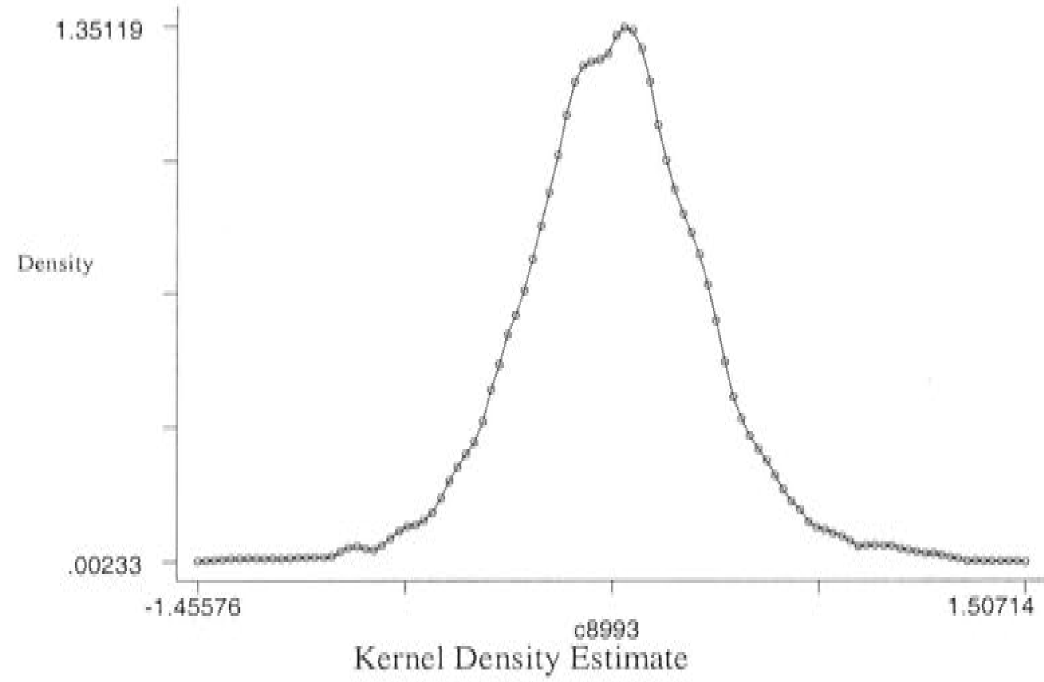

Figure7. 2: The Kernel Density Estimate of Average Log Consumption Change of Communities ($avg(gc_v)$)

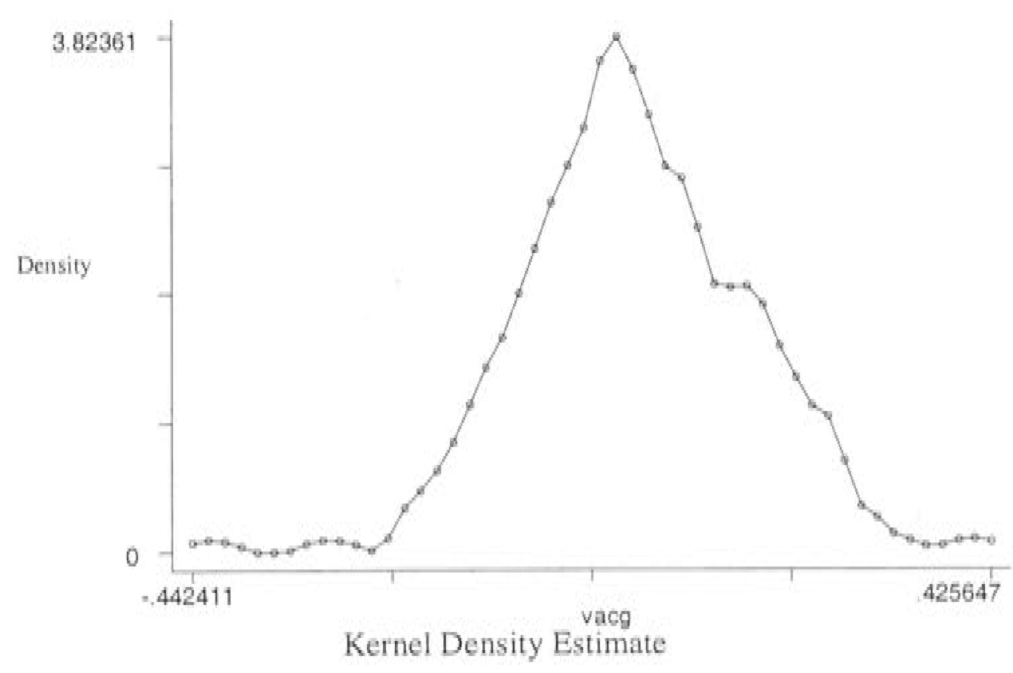

Table 7.1: Descriptive Summary of Household Variables

	Definition	Mean	Std. Dev.
$avg(gc_i)$	Household consumption growth	0.036	0.335
$avg(gc_i)^2$	Squared household consumpti growth	0.379	0.586
occup 1	Senior technical worker	0.029	0.170
occup 2	Junior technical worker	0.029	0.170
occup 3	Manager, village leader	0.065	0.240
occup 4	Office staff	0.030	0.170
occup 5	Farmer	0.510	0.500
occup 6	Skilled worker	0.092	0.288
occup 7	Non-skilled worker	0.091	0.287
occup 8	Army and police officer	0.001	0.029
occup 9	Ordinary soldier and policeman	0.001	0.034
occup 10	Driver	0.012	0.112
occup 11	The others	0.140	0.383
eduno	No education	0.372	0.823
eduprim	Primary school	0.234	0.423
edumidl	Junior middle school	0.259	0.438
edumidh	Higher middle school	0.101	0.301
edumcol	College and above	0.034	0.181
Number adults	Numbers of adult in the household	3.06	1.351

Note: The sample size is 3292.

Table 7.2: Descriptive Summary of Community Variables

Definition		Mean	Std. Dev.
$avg(gc_v)$	Average community consumption growth	0.037	0.120
$avg(gc_v)^2$	Squared average community consumption growth	0.048	0.057
Community population	Population of the community	2580	4203
Proposition of workforce in agriculture	Percentage of the work force of the community engaged in agricultural activity	0.408	0.336
Telegraph	Whether the community has access to telegraph service	0.315	0.466
Provincial newspaper	Whether the community receives a provincial newspaper daily	0.326	0.470
Dirt road	Dummy for dirt road around the community	0.281	0.451
	Residential houses are owned by:		
Owner 1	Work unit	0.258	0.439
Owner 2	Government housing office	0.146	0.354
Owner 3	Individual households	0.477	0.500
Owner 4	A mixture of all three owners listed above	0.117	0.323

Note: The sample size is 3292.

We argue that a community population may affect the scope of risk-sharing but not average community consumption growth. A similar argument is implied in choosing the number of adults in the household as the independent variable when estimating equation (1). The proportion of the workforce in agriculture (which we believe has no direct bearing on community consumption growth) will probably be associated with some specific risk. For example, a dramatic change in the weather pattern could affect the income volatility of the whole community. In the IV set, we also included certain characteristics of the community (access to telegraph, newspapers and local road conditions) on the grounds that these variables reflect the ability of communities to acquire information from the outside world that might be useful in detecting uncertainties or risks. Again, there is no *prior* reasoning that would lead us to believe that consumption growth relates to these community characteristics. Finally, the ownership structure of residential housing tells us whether the properties are owned by a work unit, government housing office, or private household. This has particular relevance for urban neighborhoods. For instance, in some neighborhoods, almost all residents are employees working for the same employer (mostly state-owned enterprises) while in others, residents may come from different work units. Homogenous communities are more exposed to risk than those that are mixed because the former relies on a more concentrated income source.[30]

It could be argued that the short length of our panel data might imply that actual squared consumption growth is a poor measure of risk. However, the Two-Stage Least Squared method will generally yield consistent estimates of the coefficient of relative prudence. Dynan also argues that the short length of the panel data is not a serious problem if the coefficient of relative prudence can be estimated precisely. In our case, we show that the coefficient of relative prudence for individual households can be estimated at a level of significance of 10%. This means that the actual squared consumption growth indeed reflects the degree of risk, not only noise.

Our empirical analysis began with estimating equation (7-1) using data at the level of individual households. Table 7.3 reports the results based on the total sample. The

[30] The homogeneity of the community may also influence the ability of residents to risk-share. Thus it is difficult to determine the sign of the effect of ownership structure on squared consumption growth, i.e., the

four sets of instrumental variables were used alternatively in order to check for robustness.

Table 7.3: 2SLS Estimate of Prudence Coefficient at Household Level (Total Sample)

	(1)	(2)	(3)	(4)
	First Stage F-Test (p-value)			
Occupation	0.000	0.001		0.000
Education	0.345		0.543	0.367
Number of adults	0.000	0.000	0.000	0.000
Regions				0.240
N	3292	3292	3292	3292
R-squared (%)	2.17	2.03	1.20	2.30
	Second Stage Regressions			
$avg(gc_i)^2$	0.30 (0.069)	0.30 (0.08)	0.32 (0.099)	0.23 (0.069)
Implied ρ	-0.40 (0.138)	-0.40 (0.200)	-0.36 (0.198)	-0.54 (0.138)
Test of over-identifying restrictions (p-value)	0.592	0.913	0.956	0.008

Note: Corrected standard errors are in parentheses.

The first stage results (the F-tests are reported) demonstrate that the instruments explain only a small part of the variability of consumption growth. The R-squared in our results is slightly lower than Dynan's. Our results show that the occupation of the household head and the number of adults in a household are significant predictors of consumption growth squared. The second stage estimation indicated that risk or uncertainty significantly and positively affect consumption growth, but the size of

uncertainty in consumption.

the estimated coefficient of $avg(gc)^2$ was very small, ranging from 0.23 to 0.32. As a result, the implied relative risk aversion coefficient turned out to be negative, which is inconsistent with the commonly held belief about its magnitude. We encountered Dynan's puzzle again in a totally different institutional and economic context.

Surprisingly, the over-identification test rejected the use of regional dummies as valid instruments.[31] This test confirmed that occupation and education are valid instruments.

In order to check if our results were driven by any difference in consumption pattern between urban neighborhoods and rural villages, we repeated the same estimation as in Table 7.3, based on the rural sample only. A very similar result emerged in Table 7.4, and again, the implied coefficient of relative risk aversion was negative.[32]

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[31] Many authors have argued that regional dummies are good instruments as in the case of the USA (Carroll et al. 1999). Their basic argument is that the regional dummy satisfies the requirements of exogeneity since most households do not choose where to live on the basis of regional differences in income variability. As to why regional dummies do not work as valid instruments in our sample, we speculate that the virtual lack of freedom of mobility of people across regions, in China, may be a factor. Because of the notable difference in the diffusion of economic reform policies across regions, the pattern of income growth varies significantly between different provinces. The residents of a poor province, that is more vulnerable to adverse climate conditions, may, at the same time, experience low consumption growth.

[32] We also ran the same regressions using urban samples and obtained a qualitatively similar result.

Table 7.4: 2SLS Estimate of Prudence Coefficient at Household Level (Rural Sample)

	(1)	(2)	(3)	(4)
	First Stage F-Test (p-value)			
Occupation	0.027	0.031		0.024
Education	0.658		0.725	0.663
Number of adults	0.000	0.000	0.000	0.000
Regions				0.257
N	2288	2288	2288	2288
R-squared (%)	1.30	1.80	1.10	2.00
	Second Stage Regressions			
$avg(gc_i)^2$	0.26 (0.101)	0.26 (0.100)	0.27 (0.100)	0.16 (0.091)
Implied ρ	-0.48 (0.202)	-0.48 (0.200)	-0.46 (0.262)	-0.68 (0.182)
Test of over-identifying restrictions (p-value)	0.722	0.903	0.186	0.117

Note: Corrected standard errors are in parentheses.

As mentioned in section III, Chinese communities use various forms of risk-sharing mechanisms to reduce the responsiveness of individual household consumption to idiosyncratic risks. This implies that the proper unit of analysis should be community representative consumers instead of individual households. Furthermore, the use of community level data will considerably decrease the possibility of measurement error. We have taken this approach because Dynan's puzzle may result from a combination of risk-sharing among households and measurement error.

Table 7.5: 2SLS Estimation of Prudence Coefficient at Community Level (Total Sample)

	(1)	(2)	(3)	(4)	(5)
	First Stage Regressions				
Village population	-0.015	-0.015	-0.014	-0.010	
	(0.008)	(0.008)	(0.008)	(0.009)	
Proportion of workforce in agriculture	-0.015	-0.016	-0.013	-0.023	
	(0.011)	(0.010)	(-0.011)	(0.012)	
Telegraph	0.022	0.025	0.023		0.021
	(0.007)	(0.007)	(0.007)		(0.007)
Provincial newspaper	0.008	0.009	0.007		0.007
	(0.008)	(0.007)	(0.008)		(0.008)
Dirt Road	-0.007		-0.005	-0.012	-0.009
	(0.008)		(0.007)	(0.009)	(0.007)
Owner1	0.012	0.010		0.007	0.007
	(0.012)	(0.012)		(0.013)	(0.012)
Owner 3	0.007	0.005		0.004	0.003
	(0.011)	(0.011)		(0.012)	(0.011)
Owner 4	0.005	0.004		0.003	0.005
	(0.014)	(0.014)		(0.015)	(0.014)
N	160	160	160	164	164
R-squared (%)	11.00	10.70	10.40	5.10	8.97
	Second Stage Regressions				
$avg(gc_v)^2$	2.25	2.40	2.31	2.12	2.32
	(0.710)	(0.730)	(0.732)	(0.961)	(0.768)
Implied ρ	3.50	3.80	3.62	3.24	3.64
	(1.420)	(1.460)	(1.464)	(1.922)	(1.536)
Test of over-identification restrictions (p-value)	0.938	0.946	0.805	0.777	0.828

Note: Corrected standard errors are in parentheses.

We estimated a community representative coefficient of relative prudence using the same data set. The results are reported in Table 7.5 and 7.6. For the total sample, five sets of instruments were used alternatively in the first stage regressions. In all specifications, the explanatory power of the instruments is reasonably large, especially in light of the first-stage results shown in Table 7.3. The coefficients of instruments describing the demographic features of communities were statistically significant with the expected signs. However the remaining instruments were less satisfactory in terms of both the level of significance and signs. For example, we do not have a good explanation for the positive correlation between access to telegraph services and the risks to which the community is exposed.

Table 7.6: 2SLS Estimation of Prudence Coefficient at Community Level (Rural Sample)

	(1)	(2)	(3)	(4)	(5)
	First Stage Regressions				
Village population	-0.021	-0.022	-0.022	-0.015	
	(0.028)	(0.027)	(0.027)	(0.009)	
Proportion of workforce in agriculture	-0.009	-0.011	-0.001	-0.002	
	(0.015)	(0.015)	(-0.001)	(0.002)	
Telegraph	0.022	0.023	0.022		0.021
	(0.007)	(0.009)	(0.009)		(0.007)
Provincial newspaper	0.006	0.007	0.007		0.007
	(0.010)	(0.009)	(0.009)		(0.008)
Dirt Road	-0.007		-0.007	-0.013	-0.008
	(0.009)		(0.008)	(0.009)	(0.008)
Owner1	0.003	0.000		0.008	0.000
	(0.017)	(0.016)		(0.018)	(0.015)
Owner 3	-0.002	-0.006		-0.005	-0.003
	(0.015)	(0.015)		(0.016)	(0.015)
Owner 4	0.013	0.010		0.021	0.014
	(0.020)	(0.020)		(0.020)	(0.019)
N	110	112	110	112	113
R-squared (%)	11.30	9.84	9.18	5.10	9.42
	Second Stage Regressions				
$avg(gc_v)^2$	1.72	1.92	1.69	1.37	2.00
	(0.860)	(0.901)	(0.907)	(1.162)	(0.926)
Implied ρ	2.44	2.84	2.38	1.74	3.00
	(1.723)	(1.802)	(1.814)	(2.324)	(1.832)
Test of over-identification restrictions (p-value)	0.569	0.522	0.301	0.628	0.647

Note: Corrected standard errors are in parentheses.

In the second stage, the coefficients of community consumption growth squared range from 2.12 to 2.40, and all of them were estimated very precisely, at a significance level of less than 5%. The implied coefficient of relative prudence ranges from 4.24 to 4.80, which indicates a strong motivation of precautionary savings. Our results are much larger than either Dynan's: ranging from 0.024 to 0.312, or Merrigan and Normandin's (1996): ranging from 0.78-1.33. We used the community as the unit of analysis, therefore the coefficients measure the responsiveness of the whole community to aggregate risks which are hard to insure against in China's current institutional context. In this sense, we believe the variations in consumption growth squared in our study represent true uncertainty while in Dynan's estimation, which is based on individual household level data, the variations may be contaminated by measurement error. To reduce the possibility that group-specific shocks drive the results, five sets of instruments were designed. The five sets of instrument variables all passed the over-identifying test. Our results are robust to different specifications.

Again, we estimated equation (7-3) with the rural sample to address possible concerns about the systematic difference between rural villages and urban neighborhoods. The results are presented in Table 7.6. The estimated coefficients on $avg(gc_i)^2$ reveal that risk positively and significantly affects consumption growth. The difference between Table 7.5 and Table 7.6 is that the magnitude and significance level of the coefficients are slightly lower for the rural sample.[33]

[33] We also redid the estimation using the urban sample (not reported here) and obtained a similar result.

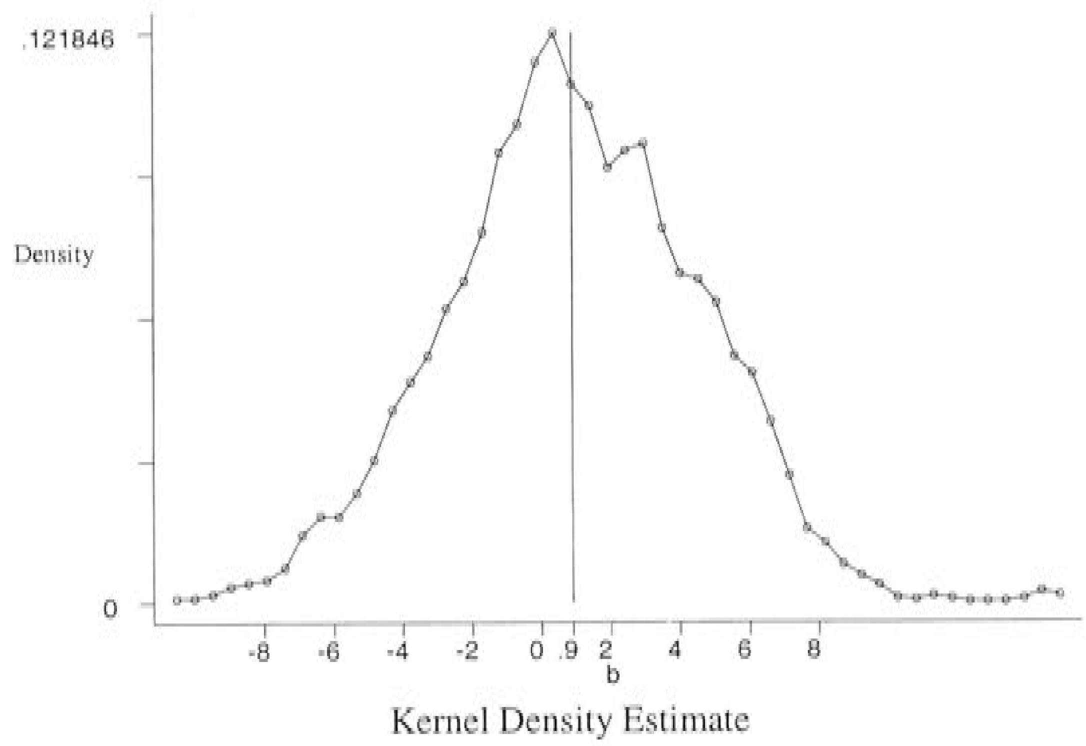
7.5. Discussion

7.5.1. The Impact of the Averaging Effect

One may question whether the simple averaging effect is the primary driving force of our estimate of the prudence coefficient for the village representative consumer. It is well known that in OLS regressions, averaging of independent variables will reduce the attenuation bias resulting from measurement error. However, it is unclear how the averaging effect influences the estimates in the 2SLS. This is particularly true in our study where we used aggregate characteristics of communities as instrumental variables instead of averaging characteristics of individual households in the communities. Given this ambiguity, we decided to try to explore the potential influence of the averaging effect on our estimates. We randomly divided the households into 150 "fictional communities" (about 22 households per community) and then estimated the prudence coefficient of the "fictional community" representative consumer with 2SLS. In our calculations, we used average education level, occupation of household heads and the average number of adults in one household as instrumental for the "fictional community". It was not possible to employ instrumental such as road conditions for the "fictional communities" in the same way as we did in Tables 5 and 6. We repeated the experiment 1,000 times. Figure 3 describes the distribution of the coefficients of $avg(gc_v)^2$. The mean of this distribution is about 0.9, in contrast with the estimates of 0.23 to 0.32 in Table 3.

This may suggest that our results are only partly driven by the averaging effect. Consumption insurance within villages is probably the key factor in arriving at our estimates. Because of the problem of picking the instrumental variable(s) for "fictional communities", we must be cautious in interpreting this experimental outcome.

Figure 3: The Kernel Density Estimate of Coefficients of $avg(gc_v)^2$



7.5.2. Log Linearized Euler Equation Method

In this paper, our specification is a linear approximation of the Euler equation. Carroll (1997) and Ludvigson and Paxson (1999) argue that low estimates of the relative prudence coefficient come from approximation bias. We estimated the coefficients of relative prudence for individual households and community representative consumers. The former is similar in size to that calculated by Dynan (1993), but the latter is much larger. This implies that the approximation bias of the log linearized Euler equation method may not be a serious problem.

7.6. Conclusion

In this paper, we estimated the relative prudence coefficient, which measures the strength of precautionary savings, focusing our estimation at the level of Chinese communities. We argue that given the features of China's institutions, Dynan's specification is better justified at the community level than at individual household level. The CHNS data offers accurate food expenditure data for a large number of households and community information for associated communities. The comparison between estimates of prudence coefficients for individual households and community representative consumers highlights some important issues related to precautionary saving and risk sharing. Our approach has the advantage of reducing measurement errors.

At individual household level, our estimation obtained a weak relative prudence coefficient similar to Dynan's. On the other hand, the relative prudence coefficient for a community representative consumer was found to be relatively large. The strong motivation of precautionary savings at community level may indicate the presence of substantial risk sharing behavior within, but not between, communities in China. Our findings indicate that households accumulate precautionary savings to insure against aggregate risks common to the whole community that cannot be effectively shared among communities.

7.7. Appendix

Detailed household food consumption data was collected during three consecutive days, which were randomly allocated from Monday to Sunday and were almost equally balanced across the seven days of the week for each sampling unit.

At the same time, state-owned and free market stores were visited and prices were collected for a representative basket of commodities for each community. This enabled us to construct food expenditure. The following method was used: Firstly, food consumed by households was categorized into classes and matched against the prices collected. A total of 40 kinds of food and prices were listed. Secondly, calculations were made to obtain real food expenditure by product at 1989 prices and the quantities of food consumed in each year. There were three kinds of prices: state store price, free market price and negotiated price. We used the free market price or negotiated price. If they were not available, we then used the state store price. The income variable came directly from the survey data.

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Chapter 8

Conclusion

8.1 Introduction

This thesis focuses on three important issues: the relationships between health and the labour markets, intra-household resource allocation and inter-household risk sharing. We use the data of the China Health Nutrition Survey of 1989, 1991 and 1993 and address questions such as: "What is the return to health in the rural labour market in China? How does allocation within the family take into consideration links between health and labour market productivity?" " Do informal insurance mechanisms shield household consumption from income fluctuations?"

8.2 Main findings

8.2.1 Return to health

Health is a kind of human capital similar to education. To understand the relationship between health and labour market outcomes, we study the health consequences of the great Chinese famine of 1959-1961. Our difference-in-differences methodology suggests that the attained height of an individual who was a baby, or who reached puberty during the famine, was 2.9 to 4.8 cm shorter than it would otherwise have been if the famine had not occurred. We also use the famine as a natural experiment to estimate the return to attained height of individuals and the economic value accompanying their return to health and strength. In this study, we find that annual income increases by 2.5 percent if attained height increases by 1 cm. This implies that the famine reduced the income of individuals during each year in the labour market by about 7-12 percent.

8.2.2 Intra household resource allocation

To further investigate the linkage between health status and labour market outcomes, we examine food allocation among family members. Chapter 3 estimates a health production function and uses it to derive individual health endowments. We also estimate the calorie intake elasticity with respect to individual health endowments for males and females. We find that health endowments affect food allocation among family members and in the context of the Chinese rural economy this elasticity is greater for women than for men.

The larger elasticity for women reflects the fact that females played an increasingly important role in farm work while males pursue job opportunities in the rural industry sector where they could earn more money. In order for husbands to be free to work in the industrial sector, it became necessary for their wives to be capable of undertaking heavier work. Women who had better health endowment and were strong enough to replace, at least partly, their husbands' role in farming, were allocated more calories to compensate for their efforts. However, women with poorer health might have received fewer calories because they could only perform light activities.

Chapter 4 assesses the effect of the location of the husband's mother-in-law in the allocation of resources between husband and wife. We find that the relative share of the husband's nutrient intake, relative to his wife's intake, decreases when his mother-in-law lives in the same village or neighbourhood, but increases if his mother-in-law lives outside the county in which the husband's family is located. The ratio of nutrient intake of the husband relative to the wife, for households in which the wife's mother lives very far away (in a different county) is, on average, 5-10% below the comparable group where the mother-in-law lives within the same county. Our test rejects the hypothesis that a multi-person household can be treated as a single decision-maker and sheds light on the degree of intra-family discrimination against the wife.

8.2.3 Inter-household risk sharing

Chapter 5 discusses risk sharing among households. The full consumption insurance hypothesis is tested. The nature of the special institutional arrangements in the Chinese economy allows us to compare the degree of insurance between rural and urban areas. The full insurance hypothesis is rejected for rural areas, but not urban. Furthermore, full insurance cannot be rejected within villages, but it is completely rejected across villages. Our results suggest that to some extent insurance deteriorates with distance. This suggests that problems with information transfers are important in explaining the pattern of insurance cover in China. The government interventions in the insurance market may be necessary to help households to achieve better risk sharing across different regions.

Chapter 6 examines the response of consumption to major illness shocks which we use to overcome the measurement errors in income shocks. The detailed information of symptoms and impacts of major illnesses allows us to test the full insurance hypothesis more precisely. The results suggest that households without medical insurance are able to insure their consumption against minor illness shocks but not major ones. This suggests that the optimal social insurance intervention should extend insurance coverage to rural areas and limited resources should be used to insure catastrophic events only. This policy would substantially improve the welfare of households in rural areas and reduce the new wave of poverty attributed to catastrophic events.

The research in previous chapters shows that there is substantial risk sharing among households. It is important to consider this risk sharing issue when analysing consumption and saving decisions within the Life Cycle and Permanent Income (LCPI) model. In Chapter 7, we combine the LCPI and risk sharing model to provide an explicit estimate of the parameters in the utility function that reflect the strength of the precautionary saving motive, using a second order Taylor expansion of the Euler equation. Our results produced a small relative prudent coefficient for the individual household, which is too small to be consistent with widely held beliefs of relative risk aversion. Meanwhile, a significant relative prudent coefficient, which is about 4 (hence the risk aversion is about 3 for the constant relative risk aversion utility function), has been estimated for village representative consumers based on group data. Our findings suggest that the village unit approach "works" in the estimation of the precautionary saving model, and this approach may be a possible way to solve Dynan's puzzle.

8.3 Future research

This thesis investigated the relationship between labour market outcomes and health, resource allocation within the family and inter-household risk sharing. It enriches our knowledge of household economic behaviour in China. However, it is just a small step ahead. Much remains to be done.

We used height to proxy health and estimated the return to height in Chapter 2. Since health is a multi-dimensional measured variable, other dimensional measures of health status such as weight, body mass index, blood pressure, nutrient intake, illness days, also need to be studied.

Due to limitations of the available data of individual wages, we may have estimated the return to height inefficiently. It may be possible to resolve this difficulty if we were able to estimate individual income through the estimation of a household farming production function. Research in this direction can be very promising. We could also examine the links between health status and productivity directly by estimating a household production function.

In our research on the return to height, we assumed that the labour supply is fixed. The relationship between health status and labour supply has been ignored in the literature. With the present data set, it is possible to exploit the effect of health on labour supply and we intend to pursue this issue in the future. This research will enrich our understanding of health and labour market outcomes.

We examined resource allocation within the family in the rural areas in China and found that calorie consumption elasticity with respect to own health endowment is larger for women than for men. Our explanation is that women are involved in more diversified activities during the transition period. The question of whether women's welfare has been improved or not needs further research.

We also extensively discussed risk sharing behaviour among households in this thesis. It may be possible in future to examine risk sharing behaviour at the individual level. We also may be able to decompose insured risk into different parts: within-family, within village (neighbourhood), within county and within province. This kind of research has two advantages. Firstly, we can test the hypothesis that the outcome of resource allocation within the family is Pareto optimal. If the family fails to share risk completely within the family, resource allocation cannot be Pareto optimal. Secondly, we have knowledge of how much risk is shared within the different scopes. This will assist policy makers to design policies that will improve the welfare of individuals.

8.4 Conclusion

This thesis confirms that health is rewarded in the rural labour market in China and that households take into account links between health and labour market productivity when food is allocated. The study also confirms that there is substantial inter-households risk sharing, particularly within the villages or neighbourhoods.

It is hoped that by contributing to our knowledge of household economic behaviour in China, this thesis will encourage further research in this field and help policy makers to formulate more effective policies such as the reform of the medical insurance and pension systems.